

TITLE OF THE INVENTION

OMEGA-CONOPEPTIDES

CROSS-REFERENCE TO RELATED APPLICATIONS

5 [0001] The present application claims benefit under 35 USC §119(e) to U.S. provisional patent applications Serial No. 60/219,616 filed on 21 July 2000 and Serial No. 60/265,888 filed on 5 February 2001. Each of these applications are incorporated herein by reference.

10 [0002] This invention was made with Government support under Grant No. PO1 GM48677 awarded by the National Institute of General Medical Sciences, National Institutes of Health, Bethesda, Maryland. The United States Government has certain rights in the invention.

BACKGROUND OF THE INVENTION

15 [0003] The invention relates to ω -conopeptides, derivatives or pharmaceutically acceptable salts thereof, and uses thereof, including the treatment of neurologic and psychiatric disorders, such as anticonvulsant agents, as neuroprotective agents, as cardiovascular agents or for the management of pain. The invention further relates to nucleic acid sequences encoding the conopeptides and encoding propeptides, as well as the propeptides.

20 [0004] The publications and other materials used herein to illuminate the background of the invention, and in particular, cases to provide additional details respecting the practice, are incorporated by reference, and for convenience are referenced in the following text by author and date and are listed alphabetically by author in the appended bibliography.

25 [0005] *Conus* is a genus of predatory marine gastropods (snails) which envenomate their prey. Venomous cone snails use a highly developed projectile apparatus to deliver their cocktail of toxic conotoxins into their prey. In fish-eating species such as *Conus magus* the cone detects the presence of the fish using chemosensors in its siphon and when close enough extends its proboscis and fires a hollow harpoon-like tooth containing venom into the fish. This immobilizes the fish and enables the cone snail to wind it into its mouth via an attached filament. For general information on *Conus* and their venom see the website address
30 <http://grimwade.biochem.unimelb.edu.au/cone/referenc.html>. Prey capture is accomplished through a sophisticated arsenal of peptides which target specific ion channel and receptor subtypes. Each *Conus* species venom appears to contain a unique set of 50-200 peptides. The composition of the venom differs greatly between species and between individual snails within

each species, each optimally evolved to paralyse its prey. The active components of the venom are small peptide toxins, typically 12-30 amino acid residues in length and are typically highly constrained peptides due to their high density of disulphide bonds.

[0006] The venoms consist of a large number of different peptide components that when separated exhibit a range of biological activities: when injected into mice they elicit a range of physiological responses from shaking to depression. The paralytic components of the venom that have been the focus of recent investigation are the α -, ω - and μ -conotoxins. All of these conotoxins act by preventing neuronal communication, but each targets a different aspect of the process to achieve this. The α -conotoxins target nicotinic ligand gated channels, the μ -conotoxins target the voltage-gated sodium channels and the ω -conotoxins target the voltage-gated calcium channels (Olivera et al., 1985; Olivera et al., 1990). For example a linkage has been established between α -, α A- & ϕ -conotoxins and the nicotinic ligand-gated ion channel; ω -conotoxins and the voltage-gated calcium channel; μ -conotoxins and the voltage-gated sodium channel; δ -conotoxins and the voltage-gated sodium channel; κ -conotoxins and the voltage-gated potassium channel; conantokins and the ligand-gated glutamate (NMDA) channel.

[0007] However, the structure and function of only a small minority of these peptides have been determined to date. For peptides where function has been determined, three classes of targets have been elucidated: voltage-gated ion channels; ligand-gated ion channels, and G-protein-linked receptors.

[0008] *Conus* peptides which target voltage-gated ion channels include those that delay the inactivation of sodium channels, as well as blockers specific for sodium channels, calcium channels and potassium channels. Peptides that target ligand-gated ion channels include antagonists of NMDA and serotonin receptors, as well as competitive and noncompetitive nicotinic receptor antagonists. Peptides which act on G-protein receptors include neurotensin and vasopressin receptor agonists. The unprecedented pharmaceutical selectivity of conotoxins is at least in part defined by a specific disulfide bond frameworks combined with hypervariable amino acids within disulfide loops (for a review see McIntosh et al., 1998).

[0009] There are drugs used in the treatment of pain, which are known in the literature and to the skilled artisan. See, for example, Merck Manual, 16th Ed. (1992). However, there is a demand for more active analgesic agents with diminished side effects and toxicity and which are non-addictive. The ideal analgesic would reduce the awareness of pain, produce analgesia over a

wide range of pain types, act satisfactorily whether given orally or parenterally, produce minimal or no side effects, be free from tendency to produce tolerance and drug dependence.

[0010] Due to the high potency and exquisite selectivity of the conopeptides, several are in various stages of clinical development for treatment of human disorders. For example, two *Conus* peptides are being developed for the treatment of pain. The most advanced is ω -conotoxin MVIIA (ziconotide), an N-type calcium channel blocker (see Heading, C., 1999; U.S. Patent No. 5,859,186). ω -Conotoxin MVIIA, isolated from *Conus magus*, is approximately 1000 times more potent than morphine, yet does not produce the tolerance or addictive properties of opiates. ω -Conotoxin MVIIA has completed Phase III (final stages) of human clinical trials and has been approved as a therapeutic agent. ω -Conotoxin MVIIA is introduced into human patients by means of an implantable, programmable pump with a catheter threaded into the intrathecal space. Preclinical testing for use in post-surgical pain is being carried out on another *Conus* peptide, contulakin-G, isolated from *Conus geographus* (Craig et al. 1999). Contulakin-G is a 16 amino acid O-linked glycopeptide whose C-terminus resembles neurotensin. It is an agonist of neurotensin receptors, but appears significantly more potent than neurotensin in inhibiting pain in *in vivo* assays.

[0011] Ischemic damage to the central nervous system (CNS) may result from either global or focal ischemic conditions. Global ischemia occurs under conditions in which blood flow to the entire brain ceases for a period of time, such as may result from cardiac arrest. Focal ischemia occurs under conditions in which a portion of the brain is deprived of its normal blood supply, such as may result from thromboembolytic occlusion of a cerebral vessel, traumatic head or spinal cord injury, edema or brain or spinal cord tumors. Both global and focal ischemic conditions have the potential for widespread neuronal damage, even if the global ischemic condition is transient or the focal condition affects a very limited area.

[0012] Epilepsy is a recurrent paroxysmal disorder of cerebral function characterized by sudden brief attacks of altered consciousness, motor activity, sensory phenomena or inappropriate behavior caused by abnormal excessive discharge of cerebral neurons. Convulsive seizures, the most common form of attacks, begin with loss of consciousness and motor control, and tonic or clonic jerking of all extremities but any recurrent seizure pattern may be termed epilepsy. The term primary or idiopathic epilepsy denotes those cases where no cause for the seizures can be identified. Secondary or symptomatic epilepsy designates the disorder when it is associated with such factors as trauma, neoplasm, infection, developmental abnormalities,

cerebrovascular disease, or various metabolic conditions. Epileptic seizures are classified as partial seizures (focal, local seizures) or generalized seizures (convulsive or nonconvulsive). Classes of partial seizures include simple partial seizures, complex partial seizures and partial seizures secondarily generalized. Classes of generalized seizures include absence seizures, atypical absence seizures, myoclonic seizures, clonic seizures, tonic seizures, tonic-clonic seizures (*grand mal*) and atonic seizures. Therapeutics having anticonvulsant properties are used in the treatment of seizures. Most therapeutics used to abolish or attenuate seizures act at least through effects that reduce the spread of excitation from seizure foci and prevent detonation and disruption of function of normal aggregates of neurons. Traditional anticonvulsants that have been utilized include phenytoin, phenobarbital, primidone, carbamazepine, ethosuximide, clonazepam and valproate. Several novel and chemically diverse anticonvulsant medications recently have been approved for marketing, including lamotrigine, ferlbamate, gabapentin and topiramate. For further details of seizures and their therapy, see Rall & Schleifer (1985) and *The Merck Manual* (1992).

[0013] In view of a large number of biologically active substances in *Conus* species it is desirable to further characterize them and to identify peptides capable of treating disorders involving voltage gated ion channels, such as stroke and pain. Surprisingly, and in accordance with this invention, Applicants have discovered novel conotoxins that can be useful for the treatment of disorders involving voltage gated ion channels and could address a long felt need for a safe and effective treatment.

SUMMARY OF THE INVENTION

[0014] The present invention is directed to ω -conopeptides, derivatives or pharmaceutically acceptable salts thereof, and uses thereof, including the treatment of neurologic and psychiatric disorders, such as anticonvulsant agents, as neuroprotective agents, as cardiovascular agents or for the management of pain. The invention is further directed to nucleic acid sequences encoding the ω -conopeptides and encoding propeptides, as well as the propeptides.

[0015] More specifically, the present invention is directed to ω -conopeptides, having the amino acid sequences set forth in Table 2 below.

[0016] The present invention is also directed to derivatives or pharmaceutically acceptable salts of the ω -conopeptides or the derivatives. Examples of derivatives include

peptides in which the Arg residues may be substituted by Lys, ornithine, homoargine, nor-Lys, N-methyl-Lys, N,N-dimethyl-Lys, N,N,N-trimethyl-Lys or any synthetic basic amino acid; the Lys residues may be substituted by Arg, ornithine, homoargine, nor-Lys, or any synthetic basic amino acid; the Tyr residues may be substituted with meta-Tyr, ortho-Tyr, nor-Tyr, mono-halo-Tyr, di-halo-Tyr, O-sulpho-Tyr, O-phospho-Tyr, nitro-Tyr or any synthetic hydroxy containing amino acid; the Ser residues may be substituted with Thr or any synthetic hydroxylated amino acid; the Thr residues may be substituted with Ser or any synthetic hydroxylated amino acid; the Phe residues may be substituted with any synthetic aromatic amino acid; the Trp residues may be substituted with Trp (D), neo-Trp, halo-Trp (D or L) or any aromatic synthetic amino acid; and the Asn, Ser, Thr or Hyp residues may be glycosylated. The halogen may be iodo, chloro, fluoro or bromo; preferably iodo for halogen substituted-Tyr and bromo for halogen-substituted Trp. The Tyr residues may also be substituted with the 3-hydroxyl or 2-hydroxyl isomers (meta-Tyr or ortho-Tyr, respectively) and corresponding O-sulpho- and O-phospho-derivatives. The acidic amino acid residues may be substituted with any synthetic acidic amino acid, e.g., tetrazolyl derivatives of Gly and Ala. The aliphatic amino acids may be substituted by synthetic derivatives bearing non-natural aliphatic branched or linear side chains C_nH_{2n+2} up to and including $n=8$. The Cys residues may be in D or L configuration and may optionally be substituted with homocysteine (D or L).

[0017] Examples of synthetic aromatic amino acid include, but are not limited to, nitro-Phe, 4-substituted-Phe wherein the substituent is C_1 - C_3 alkyl, carboxyl, hydroxymethyl, sulphomethyl, halo, phenyl, -CHO, -CN, -SO₃H and -NHAc. Examples of synthetic hydroxy containing amino acid, include, but are not limited to, such as 4-hydroxymethyl-Phe, 4-hydroxyphenyl-Gly, 2,6-dimethyl-Tyr and 5-amino-Tyr. Examples of synthetic basic amino acids include, but are not limited to, N-1-(2-pyrazolinyl)-Arg, 2-(4-piperinyl)-Gly, 2-(4-piperinyl)-Ala, 2-[3-(2S)pyrrolinyl]-Gly and 2-[3-(2S)pyrrolinyl]-Ala. These and other synthetic basic amino acids, synthetic hydroxy containing amino acids or synthetic aromatic amino acids are described in Building Block Index, Version 3.0 (1999 Catalog, pages 4-47 for hydroxy containing amino acids and aromatic amino acids and pages 66-87 for basic amino acids; see also <http://www.amino-acids.com>), incorporated herein by reference, by and available from RSP Amino Acid Analogues, Inc., Worcester, MA. Examples of synthetic acid amino acids include those derivatives bearing acidic functionality, including carboxyl, phosphate,

sulfonate and synthetic tetrazolyl derivatives such as described by Ornstein et al. (1993) and in U.S. Patent No. 5,331,001, each incorporated herein by reference.

[0018] Optionally, in the ω -conopeptides of the present invention, the Asn residues may be modified to contain an N-glycan and the Ser, Thr and Hyp residues may be modified to contain an O-glycan (e.g., g-N, g-S, g-T and g-Hyp). In accordance with the present invention, a glycan shall mean any N-, S- or O-linked mono-, di-, tri-, poly- or oligosaccharide that can be attached to any hydroxy, amino or thiol group of natural or modified amino acids by synthetic or enzymatic methodologies known in the art. The monosaccharides making up the glycan can include D-allose, D-altrose, D-glucose, D-mannose, D-gulose, D-idose, D-galactose, D-talose, D-galactosamine, D-glucosamine, D-N-acetyl-glucosamine (GlcNAc), D-N-acetyl-galactosamine (GalNAc), D-fucose or D-arabinose. These saccharides may be structurally modified, e.g., with one or more O-sulfate, O-phosphate, O-acetyl or acidic groups, such as sialic acid, including combinations thereof. The glycan may also include similar polyhydroxy groups, such as D-penicillamine 2,5 and halogenated derivatives thereof or polypropylene glycol derivatives. The glycosidic linkage is beta and 1-4 or 1-3, preferably 1-3. The linkage between the glycan and the amino acid may be alpha or beta, preferably alpha and is 1-.

[0019] Core O-glycans have been described by Van de Steen et al. (1998), incorporated herein by reference. Mucin type O-linked oligosaccharides are attached to Ser or Thr (or other hydroxylated residues of the present peptides) by a GalNAc residue. The monosaccharide building blocks and the linkage attached to this first GalNAc residue define the "core glycans," of which eight have been identified. The type of glycosidic linkage (orientation and connectivities) are defined for each core glycan. Suitable glycans and glycan analogs are described further in U.S. Serial No. 09/420,797 filed 19 October 1999 and in PCT Application No. PCT/US99/24380 filed 19 October 1999 (PCT Published Application No. WO 00/23092), each incorporated herein by reference. A preferred glycan is Gal(β 1 \rightarrow 3)GalNAc(α 1 \rightarrow).

[0020] Optionally, in the ω -conopeptides described above, pairs of Cys residues may be replaced pairwise with isoteric lactam or ester-thioether replacements, such as Ser/(Glu or Asp), Lys/(Glu or Asp) or Cys/Ala combinations. Sequential coupling by known methods (Barnay et al., 2000; Hruby et al., 1994; Bitan et al., 1997) allows replacement of native Cys bridges with lactam bridges. Thioether analogs may be readily synthesized using halo-Ala residues commercially available from RSP Amino Acid Analogues.

[0021] The present invention is further directed to a method of treating disorders associated with voltage gated ion channel disorders in a subject comprising administering to the subject an effective amount of the pharmaceutical composition comprising a therapeutically effective amount of a ω -conopeptide described herein or a pharmaceutically acceptable salt or solvate thereof. The present invention is also directed to a pharmaceutical composition comprising a therapeutically effective amount of a ω -conopeptide described herein or a pharmaceutically acceptable salt or solvate thereof and a pharmaceutically acceptable carrier.

[0022] More specifically, the present invention is further directed to uses of these peptides or nucleic acids as described herein, including the treatment of neurologic disorders, such as anticonvulsant agents, as neuroprotective agents, such as for treating stroke, as cardiovascular agents or for the management of pain.

[0023] More specifically, the present invention is also directed to nucleic acids which encode conopeptides of the present invention or which encodes precursor peptides for these conopeptides, as well as the precursor peptide. The nucleic acid sequences encoding the precursor peptides of other conopeptides of the present invention are set forth in Table 1. Table 1 also sets forth the amino acid sequences of these precursor peptides.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0024] The present invention is to ω -conopeptides, derivatives or pharmaceutically acceptable salts thereof. The present invention is further directed to the use of this peptide, derivatives thereof and pharmaceutically acceptable salts thereof for the treatment of neurologic disorders, such as anticonvulsant agents, as neuroprotective agents, such as for treating stroke, as cardiovascular agents or for the management of pain, e.g. as analgesic agents. The invention is further directed to nucleic acid sequences encoding the ω -conopeptides and encoding propeptides, as well as the propeptides.

[0025] The present invention, in another aspect, relates to a pharmaceutical composition comprising an effective amount of an ω -conopeptides, a mutein thereof, an analog thereof, an active fragment thereof or pharmaceutically acceptable salts or solvates. Such a pharmaceutical composition has the capability of acting at voltage gated ion channels, and are thus useful for treating a disorder or disease of a living animal body, including a human, which disorder or disease is responsive to the partial or complete blockade of voltage gated ion channels of the central nervous system comprising the step of administering to such a living animal body,

including a human, in need thereof a therapeutically effective amount of a pharmaceutical composition of the present invention.

[0026] Voltage-gated calcium channels are present in neurons, and in cardiac, smooth, and skeletal muscle and other excitable cells, and are known to play a variety of roles in membrane excitability, muscle contraction, and cellular secretion, such as in synaptic transmission (McCleskey). In neuronal cells, voltage-gated calcium channels have been classified by their electrophysiological as well as by their biochemical (binding) properties. Six classes of physiologically distinct calcium channels have been identified to date, namely the T, L, N, P, Q, and R-type channels.

[0027] It is well known that an accumulation of calcium (calcium overload) in the brain is seen after anoxia, ischemia, migraine and other hyperactivity periods of the brain, such as after epileptic convulsions. An uncontrolled high concentration of calcium in the cells of the central nervous system (CNS) is known to cause most of the degenerative changes connected with the above diseases. Compounds which can block the calcium channels of brain cells are therefore useful in the treatment of stroke, anoxia, ischemia, migraine, psychosis, or epilepsy, any other convulsive disorder and in the prevention of the degenerative changes connected with the same.

[0028] Compounds blocking the so called L-type calcium channels in the CNS are useful for the treatment of the above disorders by directly blocking the calcium uptake in the CNS. Further, it is well known that the so called N- and P-types of calcium channels, as well as possibly other types of calcium channels, are involved in the regulation of neurotransmitter release. Compounds blocking the N- and/or P-types of calcium channels indirectly and very powerfully prevent calcium overload in the CNS after the hyperactivity periods of the brain as described above by inhibiting the enhanced neurotransmitter release seen after such hyperactivity periods of the CNS, and especially the neurotoxic, enhanced glutamate release after such hyperactivity periods of the CNS. Furthermore, blockers of the N- and/or P-types of calcium channels, as dependent upon the selectivity of the compound in question, inhibit the release of various other neurotransmitters such as aspartate, GABA, glycine, dopamine, serotonin and noradrenaline.

[0029] Thus, the pharmaceutical compositions of the present invention are useful as neuroprotectants, cardiovascular agents, anticonvulsants, analgesics or adjuvants to general anesthetics. A "neurological disorder or disease" is a disorder or disease of the nervous system including, but not limited to, global and focal ischemic and hemorrhagic stroke, head trauma,

spinal cord injury, hypoxia-induced nerve cell damage as in cardiac arrest or neonatal distress or epilepsy. In addition, a "neurological disorder or disease" is a disease state and condition in which a neuroprotectant, anticonvulsant, analgesic and/or as an adjunct in general anesthesia may be indicated, useful, recommended or prescribed.

5 [0030] More specifically, the present invention is directed to the use of these compounds for the treatment and alleviation of epilepsy and as a general anticonvulsant agent. The present invention is also directed to the use of these compounds for reducing neurotoxic injury associated with conditions of hypoxia, anoxia or ischemia which typically follows stroke, cerebrovascular accident, brain or spinal cord trauma, myocardial infarct, physical trauma,
10 drowning, suffocation, perinatal asphyxia, or hypoglycemic events. The present invention is further directed to the use of these compounds for treating pain, including acute and chronic pain, such migraine, nociceptive and neuropathic pain. Other uses of these compounds are described in U.S. Patent No. 5,859,186, incorporated herein by reference.

[0031] A "neuroprotectant" is a compound capable of preventing the neuronal death
15 associated with a neurological disorder or disease. An "anticonvulsant" is a compound capable of reducing convulsions produced by conditions such as simple partial seizures, complex partial seizures, status epilepticus, and trauma-induced seizures such as occur following head injury, including head surgery. An "analgesic" is a compound capable of relieving pain by altering perception of nociceptive stimuli without producing anesthesia or loss of consciousness. A
20 "muscle relaxant" is a compound that reduces muscular tension. A "adjunct in general anesthesia" is a compound useful in conjunction with anesthetic agents in producing the loss of ability to perceive pain associated with the loss of consciousness.

[0032] The invention relates as well to methods useful for treatment of neurological disorders and diseases, including, but not limited to, global and focal ischemic and hemorrhagic
25 stroke, head trauma, spinal cord injury, hypoxia-induced nerve cell damage such as in cardiac arrest or neonatal distress, epilepsy or other convulsive disorders without undesirable side effects.

[0033] Thus, in one embodiment, the invention provides a method of reducing/alleviating/ decreasing the perception of pain by a subject or for inducing analgesia in a
30 subject comprising administering to the subject an effective amount of the pharmaceutical composition comprising a therapeutically effective amount of a ω -conopeptide described herein

or a pharmaceutically acceptable salt or solvate thereof. The pain may be acute, persistent, inflammatory or neuropathic pain.

[0034] In a second embodiment, the invention provides a method of treating stroke, head or spinal cord trauma or injury, anoxia, hypoxia-induced nerve cell damage, ischemia, migraine, psychosis, anxiety, schizophrenia, inflammation, movement disorder, epilepsy, any other convulsive disorder or in the prevention of the degenerative changes connected with the same in a subject comprising administering to the subject an effective amount of the pharmaceutical composition comprising a therapeutically effective amount of a ω -cono peptide described herein or a pharmaceutically acceptable salt or solvate thereof.

[0035] The ω -cono peptides described herein are sufficiently small to be chemically synthesized. General chemical syntheses for preparing the foregoing ω -cono toxin peptides are described hereinafter. Various ones of the ω -cono peptides can also be obtained by isolation and purification from specific *Conus* species using the technique described in U.S. Patent Nos. 4,447,356 (Olivera et al., 1984); 5,514,774; 5,719,264; and 5,591,821, as well as in PCT published application WO 98/03189, the disclosures of which are incorporated herein by reference.

[0036] Although the ω -cono peptides of the present invention can be obtained by purification from cone snails, because the amounts of ω -cono peptides obtainable from individual snails are very small, the desired substantially pure ω -cono peptides are best practically obtained in commercially valuable amounts by chemical synthesis using solid-phase strategy. For example, the yield from a single cone snail may be about 10 micrograms or less of ω -cono peptides peptide. By "substantially pure" is meant that the peptide is present in the substantial absence of other biological molecules of the same type; it is preferably present in an amount of at least about 85% purity and preferably at least about 95% purity. Chemical synthesis of biologically active ω -cono peptides depends of course upon correct determination of the amino acid sequence.

[0037] The ω -cono peptides can also be produced by recombinant DNA techniques well known in the art. Such techniques are described by Sambrook et al. (1989). A gene of interest (i.e., a gene that encodes a suitable ω -cono peptides) can be inserted into a cloning site of a suitable expression vector by using standard techniques. These techniques are well known to those skilled in the art. The expression vector containing the gene of interest may then be used to transfect the desired cell line. Standard transfection techniques such as calcium phosphate

co-precipitation, DEAE-dextran transfection or electroporation may be utilized. A wide variety of host/expression vector combinations may be used to express a gene encoding a conotoxin peptide of interest. Such combinations are well known to a skilled artisan. The peptides produced in this manner are isolated, reduced if necessary, and oxidized to form the correct disulfide bonds.

[0038] One method of forming disulfide bonds in the ω -conopeptides of the present invention is the air oxidation of the linear peptides for prolonged periods under cold room temperatures or at room temperature. This procedure results in the creation of a substantial amount of the bioactive, disulfide-linked peptides. The oxidized peptides are fractionated using reverse-phase high performance liquid chromatography (HPLC) or the like, to separate peptides having different linked configurations. Thereafter, either by comparing these fractions with the elution of the native material or by using a simple assay, the particular fraction having the correct linkage for maximum biological potency is easily determined. However, because of the dilution resulting from the presence of other fractions of less biopotency, a somewhat higher dosage may be required.

[0039] The peptides are synthesized by a suitable method, such as by exclusively solid-phase techniques, by partial solid-phase techniques, by fragment condensation or by classical solution couplings.

[0040] In conventional solution phase peptide synthesis, the peptide chain can be prepared by a series of coupling reactions in which constituent amino acids are added to the growing peptide chain in the desired sequence. Use of various coupling reagents, e.g., dicyclohexylcarbodiimide or diisopropylcarbonyldimidazole, various active esters, e.g., esters of N-hydroxyphthalimide or N-hydroxy-succinimide, and the various cleavage reagents, to carry out reaction in solution, with subsequent isolation and purification of intermediates, is well known classical peptide methodology. Classical solution synthesis is described in detail in the treatise, "Methoden der Organischen Chemie (Houben-Weyl): Synthese von Peptiden," (1974). Techniques of exclusively solid-phase synthesis are set forth in the textbook, "Solid-Phase Peptide Synthesis," (Stewart and Young, 1969), and are exemplified by the disclosure of U.S. Patent 4,105,603 (Vale et al., 1978). The fragment condensation method of synthesis is exemplified in U.S. Patent 3,972,859 (1976). Other available syntheses are exemplified by U.S. Patents No. 3,842,067 (1974) and 3,862,925 (1975). The synthesis of peptides containing γ -

carboxyglutamic acid residues is exemplified by Rivier et al. (1987), Nishiuchi et al. (1993) and Zhou et al. (1996).

[0041] Common to such chemical syntheses is the protection of the labile side chain groups of the various amino acid moieties with suitable protecting groups which will prevent a chemical reaction from occurring at that site until the group is ultimately removed. Usually also common is the protection of an α -amino group on an amino acid or a fragment while that entity reacts at the carboxyl group, followed by the selective removal of the α -amino protecting group to allow subsequent reaction to take place at that location. Accordingly, it is common that, as a step in such a synthesis, an intermediate compound is produced which includes each of the amino acid residues located in its desired sequence in the peptide chain with appropriate side-chain protecting groups linked to various ones of the residues having labile side chains.

[0042] As far as the selection of a side chain amino protecting group is concerned, generally one is chosen which is not removed during deprotection of the α -amino groups during the synthesis. However, for some amino acids, e.g., His, protection is not generally necessary. In selecting a particular side chain protecting group to be used in the synthesis of the peptides, the following general rules are followed: (a) the protecting group preferably retains its protecting properties and is not split off under coupling conditions, (b) the protecting group should be stable under the reaction conditions selected for removing the α -amino protecting group at each step of the synthesis, and (c) the side chain protecting group must be removable, upon the completion of the synthesis containing the desired amino acid sequence, under reaction conditions that will not undesirably alter the peptide chain.

[0043] It should be possible to prepare many, or even all, of these peptides using recombinant DNA technology. However, when peptides are not so prepared, they are preferably prepared using the Merrifield solid-phase synthesis, although other equivalent chemical syntheses known in the art can also be used as previously mentioned. Solid-phase synthesis is commenced from the C-terminus of the peptide by coupling a protected α -amino acid to a suitable resin. Such a starting material can be prepared by attaching an α -amino-protected amino acid by an ester linkage to a chloromethylated resin or a hydroxymethyl resin, or by an amide bond to a benzhydrylamine (BHA) resin or paramethylbenzhydrylamine (MBHA) resin. Preparation of the hydroxymethyl resin is described by Bodansky et al. (1966). Chloromethylated resins are commercially available from Bio Rad Laboratories (Richmond, CA) and from Lab. Systems, Inc. The preparation of such a resin is described by Stewart and

Young (1969). BHA and MBHA resin supports are commercially available, and are generally used when the desired polypeptide being synthesized has an unsubstituted amide at the C-terminus. Thus, solid resin supports may be any of those known in the art, such as one having the formulae $-O-CH_2$ -resin support, $-NH$ BHA resin support, or $-NH$ -MBHA resin support.

5 When the unsubstituted amide is desired, use of a BHA or MBHA resin is preferred, because cleavage directly gives the amide. In case the N-methyl amide is desired, it can be generated from an N-methyl BHA resin. Should other substituted amides be desired, the teaching of U.S. Patent No. 4,569,967 (Kornreich et al., 1986) can be used, or should still other groups than the free acid be desired at the C-terminus, it may be preferable to synthesize the peptide using
10 classical methods as set forth in the Houben-Weyl text (1974).

[0044] The C-terminal amino acid, protected by Boc or Fmoc and by a side-chain protecting group, if appropriate, can be first coupled to a chloromethylated resin according to the procedure set forth in K. Horiki et al. (1978), using KF in DMF at about 60°C for 24 hours with stirring, when a peptide having free acid at the C-terminus is to be synthesized. Following the
5 coupling of the BOC-protected amino acid to the resin support, the α -amino protecting group is removed, as by using trifluoroacetic acid (TFA) in methylene chloride or TFA alone. The deprotection is carried out at a temperature between about 0°C and room temperature. Other standard cleaving reagents, such as HCl in dioxane, and conditions for removal of specific α -amino protecting groups may be used as described in Schroder & Lubke (1965).

20 [0045] After removal of the α -amino-protecting group, the remaining α -amino- and side chain-protected amino acids are coupled step-wise in the desired order to obtain the intermediate compound defined hereinbefore, or as an alternative to adding each amino acid separately in the synthesis, some of them may be coupled to one another prior to addition to the solid phase reactor. Selection of an appropriate coupling reagent is within the skill of the art. Particularly
25 suitable as a coupling reagent is N,N'-dicyclohexylcarbodiimide (DCC, DIC, HBTU, HATU, TBTU in the presence of HoBt or HoAt).

[0046] The activating reagents used in the solid phase synthesis of the peptides are well known in the peptide art. Examples of suitable activating reagents are carbodiimides, such as N,N'-diisopropylcarbodiimide and N-ethyl-N'-(3-dimethylaminopropyl)carbodiimide. Other
30 activating reagents and their use in peptide coupling are described by Schroder & Lubke (1965) and Kapoor (1970).

[0047] Each protected amino acid or amino acid sequence is introduced into the solid-phase reactor in about a twofold or more excess, and the coupling may be carried out in a medium of dimethylformamide (DMF):CH₂Cl₂ (1:1) or in DMF or CH₂Cl₂ alone. In cases where intermediate coupling occurs, the coupling procedure is repeated before removal of the α-amino protecting group prior to the coupling of the next amino acid. The success of the coupling reaction at each stage of the synthesis, if performed manually, is preferably monitored by the ninhydrin reaction, as described by Kaiser et al. (1970). Coupling reactions can be performed automatically, as on a Beckman 990 automatic synthesizer, using a program such as that reported in Rivier et al. (1978).

[0048] After the desired amino acid sequence has been completed, the intermediate peptide can be removed from the resin support by treatment with a reagent, such as liquid hydrogen fluoride or TFA (if using Fmoc chemistry), which not only cleaves the peptide from the resin but also cleaves all remaining side chain protecting groups and also the α-amino protecting group at the N-terminus if it was not previously removed to obtain the peptide in the form of the free acid. If Met is present in the sequence, the Boc protecting group is preferably first removed using trifluoroacetic acid (TFA)/ethanedithiol prior to cleaving the peptide from the resin with HF to eliminate potential S-alkylation. When using hydrogen fluoride or TFA for cleaving, one or more scavengers such as anisole, cresol, dimethyl sulfide and methylethyl sulfide are included in the reaction vessel.

[0049] Cyclization of the linear peptide is preferably affected, as opposed to cyclizing the peptide while a part of the peptido-resin, to create bonds between Cys residues. To effect such a disulfide cyclizing linkage, fully protected peptide can be cleaved from a hydroxymethylated resin or a chloromethylated resin support by ammonolysis, as is well known in the art, to yield the fully protected amide intermediate, which is thereafter suitably cyclized and deprotected. Alternatively, deprotection, as well as cleavage of the peptide from the above resins or a benzhydrylamine (BHA) resin or a methylbenzhydrylamine (MBHA), can take place at 0°C with hydrofluoric acid (HF) or TFA, followed by oxidation as described above.

[0050] The peptides are also synthesized using an automatic synthesizer. Amino acids are sequentially coupled to an MBHA Rink resin (typically 100 mg of resin) beginning at the C-terminus using an Advanced Chemtech 357 Automatic Peptide Synthesizer. Couplings are carried out using 1,3-diisopropylcarbodiimide in N-methylpyrrolidinone (NMP) or by 2-(1H-benzotriazole-1-yl)-1,1,3,3-tetramethyluronium hexafluorophosphate (HBTU) and diethylisopro-

pylethylamine (DIEA). The Fmoc protecting group is removed by treatment with a 20% solution of piperidine in dimethylformamide(DMF). Resins are subsequently washed with DMF (twice), followed by methanol and NMP.

[0051] Muteins, analogs or active fragments, of the foregoing conotoxin peptides are also contemplated here. See, e.g., Hammerland et al. (1992). Derivative muteins, analogs or active fragments of the conotoxin peptides may be synthesized according to known techniques, including conservative amino acid substitutions, such as outlined in U.S. Patent Nos. 5,545,723 (see particularly col. 2, line 50--col. 3, line 8); 5,534,615 (see particularly col. 19, line 45--col. 22, line 33); and 5,364,769 (see particularly col. 4, line 55--col. 7, line 26), each herein incorporated by reference.

[0052] The ω -conopeptides of the present invention are also useful to reduce neurotoxic injury associated with conditions of hypoxia, anoxia or ischemia which typically follows stroke, cerebrovascular accident, brain or spinal chord trauma, myocardial infarct, physical trauma, drownings, suffocation, perinatal asphyxia, or hypoglycemic events. To reduce neurotoxic injury, an ω -conopeptide should be administered in a therapeutically effective amount to the patient within 24 hours of the onset of the hypoxic, anoxic or ischemic condition in order for the ω -conopeptide to effectively minimize the CNS damage which the patient will experience.

[0053] The ω -conopeptides of the present invention are further useful in controlling pain, e.g., as analgesic agents, and the treatment of migraine, acute pain or persistent pain. They can be used prophylactically or to relieve the symptoms associated with a migraine episode, or to treat acute or persistent pain. For these uses, an ω -conopeptide is administered in a therapeutically effective amount to overcome or to ease the pain.

[0054] Pharmaceutical compositions containing a compound of the present invention as the active ingredient can be prepared according to conventional pharmaceutical compounding techniques. See, for example, *Remington's Pharmaceutical Sciences*, 18th Ed. (1990, Mack Publishing Co., Easton, PA). Typically, an antagonistic amount of active ingredient will be admixed with a pharmaceutically acceptable carrier. The carrier may take a wide variety of forms depending on the form of preparation desired for administration, e.g., intravenous, oral, parenteral or intrathecally. For examples of delivery methods see U.S. Patent No. 5,844,077, incorporated herein by reference.

[0055] "Pharmaceutical composition" means physically discrete coherent portions suitable for medical administration. "Pharmaceutical composition in dosage unit form" means

physically discrete coherent units suitable for medical administration, each containing a daily dose or a multiple (up to four times) or a sub-multiple (down to a fortieth) of a daily dose of the active compound in association with a carrier and/or enclosed within an envelope. Whether the composition contains a daily dose, or for example, a half, a third or a quarter of a daily dose, will depend on whether the pharmaceutical composition is to be administered once or, for example, twice, three times or four times a day, respectively.

[0056] The term "salt", as used herein, denotes acidic and/or basic salts, formed with inorganic or organic acids and/or bases, preferably basic salts. While pharmaceutically acceptable salts are preferred, particularly when employing the compounds of the invention as medicaments, other salts find utility, for example, in processing these compounds, or where non-medicament-type uses are contemplated. Salts of these compounds may be prepared by art-recognized techniques.

[0057] Examples of such pharmaceutically acceptable salts include, but are not limited to, inorganic and organic addition salts, such as hydrochloride, sulphates, nitrates or phosphates and acetates, trifluoroacetates, propionates, succinates, benzoates, citrates, tartrates, fumarates, maleates, methane-sulfonates, isothionates, theophylline acetates, salicylates, respectively, or the like. Lower alkyl quaternary ammonium salts and the like are suitable, as well.

[0058] As used herein, the term "pharmaceutically acceptable" carrier means a non-toxic, inert solid, semi-solid liquid filler, diluent, encapsulating material, formulation auxiliary of any type, or simply a sterile aqueous medium, such as saline. Some examples of the materials that can serve as pharmaceutically acceptable carriers are sugars, such as lactose, glucose and sucrose, starches such as corn starch and potato starch, cellulose and its derivatives such as sodium carboxymethyl cellulose, ethyl cellulose and cellulose acetate; powdered tragacanth; malt, gelatin, talc; excipients such as cocoa butter and suppository waxes; oils such as peanut oil, cottonseed oil, safflower oil, sesame oil, olive oil, corn oil and soybean oil; glycols, such as propylene glycol, polyols such as glycerin, sorbitol, mannitol and polyethylene glycol; esters such as ethyl oleate and ethyl laurate, agar; buffering agents such as magnesium hydroxide and aluminum hydroxide; alginic acid; pyrogen-free water; isotonic saline, Ringer's solution; ethyl alcohol and phosphate buffer solutions, as well as other non-toxic compatible substances used in pharmaceutical formulations.

[0059] Wetting agents, emulsifiers and lubricants such as sodium lauryl sulfate and magnesium stearate, as well as coloring agents, releasing agents, coating agents, sweetening,

flavoring and perfuming agents, preservatives and antioxidants can also be present in the composition, according to the judgment of the formulator. Examples of pharmaceutically acceptable antioxidants include, but are not limited to, water soluble antioxidants such as ascorbic acid, cysteine hydrochloride, sodium bisulfite, sodium metabisulfite, sodium sulfite, and the like; oil soluble antioxidants, such as ascorbyl palmitate, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), lecithin, propyl gallate, alpha-tocopherol and the like; and the metal chelating agents such as citric acid, ethylenediamine tetraacetic acid (EDTA), sorbitol, tartaric acid, phosphoric acid and the like.

[0060] For oral administration, the compounds can be formulated into solid or liquid preparations such as capsules, pills, tablets, lozenges, melts, powders, suspensions or emulsions.

In preparing the compositions in oral dosage form, any of the usual pharmaceutical media may be employed, such as, for example, water, glycols, oils, alcohols, flavoring agents, preservatives, coloring agents, suspending agents, and the like in the case of oral liquid preparations (such as, for example, suspensions, elixirs and solutions); or carriers such as starches, sugars, diluents, granulating agents, lubricants, binders, disintegrating agents and the like in the case of oral solid preparations (such as, for example, powders, capsules and tablets). Because of their ease in administration, tablets and capsules represent the most advantageous oral dosage unit form, in which case solid pharmaceutical carriers are obviously employed. If desired, tablets may be sugar-coated or enteric-coated by standard techniques. The active agent can be encapsulated to make it stable to passage through the gastrointestinal tract while at the same time allowing for passage across the blood brain barrier. See for example, WO 96/11698.

[0061] For parenteral administration, the compound may be dissolved in a pharmaceutical carrier and administered as either a solution or a suspension. Illustrative of suitable carriers are water, saline, dextrose solutions, fructose solutions, ethanol, or oils of animal, vegetative or synthetic origin. The carrier may also contain other ingredients, for example, preservatives, suspending agents, solubilizing agents, buffers and the like. When the compounds are being administered intrathecally, they may also be dissolved in cerebrospinal fluid.

[0062] A variety of administration routes are available. The particular mode selected will depend of course, upon the particular drug selected, the severity of the disease state being treated and the dosage required for therapeutic efficacy. The methods of this invention, generally speaking, may be practiced using any mode of administration that is medically acceptable,

meaning any mode that produces effective levels of the active compounds without causing clinically unacceptable adverse effects. Such modes of administration include oral, rectal, sublingual, topical, nasal, transdermal or parenteral routes. The term "parenteral" includes subcutaneous, intravenous, epidural, irrigation, intramuscular, release pumps, or infusion.

5 [0063] For example, administration of the active agent according to this invention may be achieved using any suitable delivery means, including:

(a) pump (see, e.g., Luer & Hatton (1993), Zimm et al. (1984) and Ettinger et al. (1978));

(b), microencapsulation (see, e.g., U.S. Patent Nos. 4,352,883; 4,353,888; and 5,084,350);

10 (c) continuous release polymer implants (see, e.g., U.S. Patent No. 4,883,666);

(d) macroencapsulation (see, e.g., U.S. Patent Nos. 5,284,761, 5,158,881, 4,976,859 and 4,968,733 and published PCT patent applications WO92/19195, WO 95/05452);

(e) naked or unencapsulated cell grafts to the CNS (see, e.g., U.S. Patent Nos. 5,082,670 and 5,618,531);

15 (f) injection, either subcutaneously, intravenously, intra-arterially, intramuscularly, or to other suitable site; or

(g) oral administration, in capsule, liquid, tablet, pill, or prolonged release formulation.

[0064] In one embodiment of this invention, an active agent is delivered directly into the CNS, preferably to the brain ventricles, brain parenchyma, the intrathecal space or other suitable
20 CNS location, most preferably intrathecally.

[0065] Alternatively, targeting therapies may be used to deliver the active agent more specifically to certain types of cell, by the use of targeting systems such as antibodies or cell specific ligands. Targeting may be desirable for a variety of reasons, e.g. if the agent is unacceptably toxic, or if it would otherwise require too high a dosage, or if it would not
25 otherwise be able to enter the target cells.

[0066] The active agents, which are peptides, can also be administered in a cell based delivery system in which a DNA sequence encoding an active agent is introduced into cells designed for implantation in the body of the patient, especially in the spinal cord region. Suitable delivery systems are described in U.S. Patent No. 5,550,050 and published PCT
30 Application Nos. WO 92/19195, WO 94/25503, WO 95/01203, WO 95/05452, WO 96/02286, WO 96/02646, WO 96/40871, WO 96/40959 and WO 97/12635. Suitable DNA sequences can

be prepared synthetically for each active agent on the basis of the developed sequences and the known genetic code.

[0067] The active agent is preferably administered in an therapeutically effective amount. By a "therapeutically effective amount" or simply "effective amount" of an active compound is meant a sufficient amount of the compound to treat the desired condition at a reasonable benefit/risk ratio applicable to any medical treatment. The actual amount administered, and the rate and time-course of administration, will depend on the nature and severity of the condition being treated. Prescription of treatment, e.g. decisions on dosage, timing, etc., is within the responsibility of general practitioners or spealists, and typically takes account of the disorder to be treated, the condition of the individual patient, the site of delivery, the method of administration and other factors known to practitioners. Examples of techniques and protocols can be found in *Remington's Parmaceutical Sciences*.

[0068] Dosage may be adjusted appropriately to achieve desired drug levels, locally or systemically. Typically the active agents of the present invention exhibit their effect at a dosage range from about 0.001 mg/kg to about 250 mg/kg, preferably from about 0.01 mg/kg to about 100 mg/kg of the active ingredient, more preferably from a bout 0.05 mg/kg to about 75 mg/kg. A suitable dose can be administered in multiple sub-doses per day. Typically, a dose or sub-dose may contain from about 0.1 mg to about 500 mg of the active ingredient per unit dosage form. A more preferred dosage will contain from about 0.5 mg to about 100 mg of active ingredient per unit dosage form. Dosages are generally initiated at lower levels and increased until desired effects are achieved. In the event that the response in a subject is insufficient at such doses, even higher doses (or effective higher doses by a different, more localized delivery route) may be employed to the extent that patient tolerance permits. Continuous dosing over, for example 24 hours or multiple doses per day are contemplated to achieve appropriate systemic levels of compounds.

[0069] For the treatment of pain, if the route of administration is directly to the CNS, the dosage contemplated is from about 1 ng to about 100 mg per day, preferably from about 100 ng to about 10 mg per day, more preferably from about 1 µg to about 100 µg per day. If administered peripherally, the dosage contemplated is somewhat higher, from about 100 ng to about 1000 mg per day, preferably from about 10 µg to about 100 mg per day, more preferably from about 100 µg to about 10 mg per day. If the conopeptide is delivered by continuous

infusion (e.g., by pump delivery, biodegradable polymer delivery or cell-based delivery), then a lower dosage is contemplated than for bolus delivery.

[0070] Advantageously, the compositions are formulated as dosage units, each unit being adapted to supply a fixed dose of active ingredients. Tablets, coated tablets, capsules, ampoules and suppositories are examples of dosage forms according to the invention.

[0071] It is only necessary that the active ingredient constitute an effective amount, i.e., such that a suitable effective dosage will be consistent with the dosage form employed in single or multiple unit doses. The exact individual dosages, as well as daily dosages, are determined according to standard medical principles under the direction of a physician or veterinarian for use humans or animals.

[0072] The pharmaceutical compositions will generally contain from about 0.0001 to 99 wt. %, preferably about 0.001 to 50 wt. %, more preferably about 0.01 to 10 wt.% of the active ingredient by weight of the total composition. In addition to the active agent, the pharmaceutical compositions and medicaments can also contain other pharmaceutically active compounds. Examples of other pharmaceutically active compounds include, but are not limited to, analgesic agents, cytokines and therapeutic agents in all of the major areas of clinical medicine. When used with other pharmaceutically active compounds, the conopeptides of the present invention may be delivered in the form of drug cocktails. A cocktail is a mixture of any one of the compounds useful with this invention with another drug or agent. In this embodiment, a common administration vehicle (e.g., pill, tablet, implant, pump, injectable solution, etc.) would contain both the instant composition in combination supplementary potentiating agent. The individual drugs of the cocktail are each administered in therapeutically effective amounts. A therapeutically effective amount will be determined by the parameters described above; but, in any event, is that amount which establishes a level of the drugs in the area of body where the drugs are required for a period of time which is effective in attaining the desired effects.

[0073] The practice of the present invention employs, unless otherwise indicated, conventional techniques of chemistry, molecular biology, microbiology, recombinant DNA, genetics, immunology, cell biology, cell culture and transgenic biology, which are within the skill of the art. See, e.g., Maniatis *et al.*, 1982; Sambrook *et al.*, 1989; Ausubel *et al.*, 1992; Glover, 1985; Anand, 1992; Guthrie and Fink, 1991; Harlow and Lane, 1988; Jakoby and Pastan, 1979; *Nucleic Acid Hybridization* (B. D. Hames & S. J. Higgins eds. 1984);

Transcription And Translation (B. D. Hames & S. J. Higgins eds. 1984); *Culture Of Animal Cells* (R. I. Freshney, Alan R. Liss, Inc., 1987); *Immobilized Cells And Enzymes* (IRL Press, 1986); B. Perbal, *A Practical Guide To Molecular Cloning* (1984); the treatise, *Methods In Enzymology* (Academic Press, Inc., N.Y.); *Gene Transfer Vectors For Mammalian Cells* (J. H. Miller and M. P. Calos eds., 1987, Cold Spring Harbor Laboratory); *Methods In Enzymology*, Vols. 154 and 155 (Wu et al. eds.), *Immunochemical Methods In Cell And Molecular Biology* (Mayer and Walker, eds., Academic Press, London, 1987); *Handbook Of Experimental Immunology*, Volumes I-IV (D. M. Weir and C. C. Blackwell, eds., 1986); Riott, *Essential Immunology*, 6th Edition, Blackwell Scientific Publications, Oxford, 1988; Hogan et al., *Manipulating the Mouse Embryo*, (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., 1986).

EXAMPLES

[0074] The present invention is described by reference to the following Examples, which are offered by way of illustration and are not intended to limit the invention in any manner. Standard techniques well known in the art or the techniques specifically described below were utilized.

EXAMPLE 1

Isolation of ω -Conotoxins

[0075] Crude venom was extracted from venom ducts (Cruz et al., 1976), and the components were purified as previously described (Cartier et al., 1996). The crude extract from venom ducts was purified by reverse phase liquid chromatography (RPLC) using a Vydac C₁₈ semi-preparative column (10 x 250 mm). Further purification of bioactive peaks was done on a Vydac C₁₈ analytical column (4.6 x 220 mm). The effluents were monitored at 220 nm. Peaks were collected, and aliquots were assayed for activity. Throughout purification, HPLC fractions were assayed by means of intracerebral ventricular (i.c.v.) injection into mice (Clark et al., 1981).

[0076] The amino acid sequence of the purified peptides were determined by standard methods. The purified peptides were reduced and alkylated prior to sequencing by automated Edman degradation on an Applied Biosystems 477A Protein Sequencer with a 120A Analyzer (DNA/Peptide Facility, University of Utah) (Martinez et al., 1995; Shon et al., 1994).

[0077] In accordance with this method, the ω -conopeptides described as "isolated" in Table 1 were obtained. These ω -conopeptides, as well as the other ω -conopeptides and the ω -conopeptide precursors set forth in Table 1 are synthesized as described in U.S. Patent No. 5,591,821.

EXAMPLE 2

Isolation of DNA Encoding ω -Conopeptides

[0078] DNA coding for ω -conopeptides was isolated and cloned in accordance with conventional techniques using general procedures well known in the art, such as described in Olivera et al. (1996). Alternatively, cDNA libraries was prepared from *Conus* venom duct using conventional techniques. DNA from single clones was amplified by conventional techniques using primers which correspond approximately to the M13 universal priming site and the M13 reverse universal priming site. Clones having a size of approximately 300-500 nucleotides were sequenced and screened for similarity in sequence to known ω -conotoxins. The DNA sequences and encoded propeptide sequences are set forth in Table 1. DNA sequences coding for the mature toxin can also be prepared on the basis of the DNA sequences set forth in Table 1. An alignment of the ω -conopeptides of the present invention is set forth in Table 2.

TABLE 1

DNA and Amino Acid Sequences of ω -Conopeptides and Precursors

Name: J410

Species:

Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGCATGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGT
CAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCATGCCCTGAGGTC
GACCACCAATTTCTCCACGTTGACTCGTCGCTGCCTTTCTCCCGGATCACGATGTCA
TAAGACAATGCGTAACTGCTGCACTTCATGCTCTTCATACAAAGGGAAATGTCGGCC
TCGAAAATGAACCACTCATCACCTACTCCTCTGGAGGCCTCAGAGGAATTACATTGA
AATAAAAGCCGCATTACAAAAA (SEQ ID NO:1)

Translation:

MKLTCMVIVAVLLLACQLITADDSRGTQKHHLRSTTNFSTLTRRCLSPGSRCHKTM
NCCTSCSSYKGKCRPRK (SEQ ID NO:2)

Toxin Sequence:

Cys-Leu-Ser-Xaa3-Gly-Ser-Arg-Cys-His-Lys-Thr-Met-Arg-Asn-Cys-Cys-Thr-Ser-Cys-Ser-Ser-Xaa5-Lys-Gly-Lys-Cys-Arg-Xaa3-Arg-Lys-^ (SEQ ID NO:3)

5

Name: J411
Species:
Cloned: Yes

10 **DNA Sequence:**

GGATCCATGAAACTGACGTGCGTGCGTGATCGTCGCCGTGCTGCTCCTGACGGTCTGT
 CAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCATGCCCTGAGGTC
 GACCACCAATTTCTCCACGTGCGTCTGCTGCAAACCTCCCGGAAGAAAATGTCT
 GAATAGAAAGAATGAATGCTGCAGCAAGTTTTGCAATGAACACCTACATATGTGTG
 15 GATAAATGGCTAAAAACTGAATAAAAGCCGCATTGCAAAAAAAAAAAAAAAAAAAAA
 AA (SEQ ID NO:4)

Translation:

MKLTCVVIVAVLLLTVCLITADDSRGTQKHHLRSTTNFSTSTRRCKPPGRKCLNRKN
 20 ECCSKFCNEHLHMC (SEQ ID NO:5)

Toxin Sequence:

Cys-Lys-Xaa3-Xaa3-Gly-Arg-Lys-Cys-Leu-Asn-Arg-Lys-Asn-Xaa1-Cys-Cys-Ser-Lys-Phe-
 Cys-Asn-Xaa1-His-Leu-His-Met-Cys-# (SEQ ID NO:6)

25

Name: J413
Species:
Cloned: Yes

30

DNA Sequence:

GGATCCATGAAACTGACGTGCGTGCGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGT
 CAACTCGTCACAGCTGATGGCTCCAGAGGTATGCAGAAGCATTATGCCCTGAGGTC
 GACCACCAATCTCTCCATATCGTCTCGCTGCAAACCTCCCAGAAGAAAATGTCTGAA
 35 GATTAAGGATAAATGCTGCAACTTTTGAATACACACCTAAATATGTGTGGATAAAT
 GGCTAAAAACTGAATAAAAGCCGCATTGCAAAAAAAAAAAAAAAAAAAAA (SEQ ID
 NO:7)

Translation:

MKLTCVVIVAVLLLTAQLVTADGSRGMQKHIALRSTTNLSISSRCKPPRRKCLKIKDK
 40 CCNFCNTHLNMCG (SEQ ID NO:8)

Toxin Sequence:

Cys-Lys-Xaa3-Xaa3-Arg-Arg-Lys-Cys-Leu-Lys-Ile-Lys-Asp-Lys-Cys-Cys-Asn-Phe-Cys-Asn-
 45 Thr-His-Leu-Asn-Met-Cys-# (SEQ ID NO:9)

Name: J414
Species:
Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGATGGCCTGT
 CAACTCGTCACAGCTGATGGCTCCAGAGGTATGCACAAGCATTATGCCCTGAGGTC
 GACCACCAAACCTCTCCATGTCTGACTCGCTGCGCAGGTCCAGGAACAATTTGTCCTAA
 TAGGGTATGCTGCGGTTATTGCAGTAAAAGAACACATCTATGTCATTTCGCGAACTGG
 CTGATCTTCCCCCTTCTGCGCTCCATCCTTTTCTGCCTGAGTCCTCCATACCTGAGAA
 TGGTCATGAACCACTCAACACCTACTCCTCTGGAGGGCCTCAGAAGAGCTACATTG
 AAATAAAAGCCGCATTACAAAAAAAAAAAAAAAAAAAAA (SEQ ID NO:10)

Translation:

MKLTCVVIVAVLLLMACQLVTADGSRGMHKHYALRSTTKLSMSTRCAGPGTICPNRVC
 CGYCSKRTHLCHSRTG (SEQ ID NO:11)

Toxin Sequence:

Cys-Ala-Gly-Xaa3-Gly-Thr-Ile-Cys-Xaa3-Asn-Arg-Val-Cys-Cys-Gly-Xaa5-Cys-Ser-Lys-Arg-
 Thr-His-Leu-Cys-His-Ser-Arg-Thr-# (SEQ ID NO:12)

Name: Ar6.10
Species: arenatus
Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGCATGGTGATCATCGCCGTGCTGTTTCCTGACGGCCTGT
 CAACTCATTACAGGTGAGCAGAAGGACCATGCTCTGAGGTCAACTGACAAAAACTC
 CAAGTTGACTAGGCAGTGCTCGGCTAACGGTGGATCTTGTACTCGTCATTTTCACTG
 CTGCAGCCTCTATTGCAATAAAGATTCCAGTGTATGTGTGGCAACCTCATACCCGTG
 AGTGGCCATGAACCCCTCAATACCCTCTCCTCTGGAGGCTTCAGAGGAAGTGCATTG
 AAATAAAACCGCATTGCAATAAAAAAAAAAAAAAAAAAAAAA (SEQ ID NO:13)

Translation:

MKLTCMVIIAVLFLTACQLITGEQKDHALRSTDKN SKLTRQCSANGGSCTRHFHCCSLY
 CNKDSSVCVATSYP (SEQ ID NO:14)

Toxin Sequence:

Xaa2-Cys-Ser-Ala-Asn-Gly-Gly-Ser-Cys-Thr-Arg-His-Phe-His-Cys-Cys-Ser-Leu-Xaa5-Cys-
 Asn-Lys-Asp-Ser-Ser-Val-Cys-Val-Ala-Thr-Ser-Xaa5-Xaa3-^ (SEQ ID NO:15)

Name: Ar6.2
Species: arenatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGCGTGTTGATTATCGCCGTGCTGTTC
 CTGACGGCCTGTCAACTCATTACAGCTGAGACTTACTCCAGAGGTGAGCAGAAGCA
 CCATGCTCTGAGGTCAACTGACAGAACTCCAAGTTGACCAGGACATGCAACACTC
 5 CCACTGAATATTGTACTTTGCATCGACACTGCTGCAGCGGCTACTGCCATAAAACAA
 TCCAGGCATGTTTCATAATACCGGTGAGTGGTCATGAACCACTCAATACCCTCTCCTC
 TGGAGGCTTCAGAGGAACTGCATTGAAATAAAAGCCGCATTGC (SEQ ID NO:16)

Translation:

10 MKLTCVLIIAVLFLTACQLITAETYSRGEQKHHLRSTDRNSKLTRTCNTPTEYCTLHRH
 CCSGYCHKTIQACS (SEQ ID NO:17)

Toxin Sequence:

15 Thr-Cys-Asn-Thr-Xaa3-Thr-Xaa1-Xaa5-Cys-Thr-Leu-His-Arg-His-Cys-Cys-Ser-Gly-Xaa5-
 Cys-His-Lys-Thr-Ile-Gln-Ala-Cys-Ser-^ (SEQ ID NO:18)

Name: Ar6.3

Species: arenatus

20 **Cloned:** Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGCGTGTTGATCATCGCCGTGCTGTTC
 CTGACGGCCTGTCAACTCATTACAGCTGAGACTTACTCCAGAGGTGAGCAGATGCA
 25 CCGTGCTCTGAGGTCAACTGACAAAACTCCAAGTTGACTAGGCAGTGACACGCCTA
 ACGGTGGATCTTGTTCTCGTCATTTTCACTGCTGCAGCCTCTATTGCAATAAAAAGTA
 CTGGCGTATGTATTGCAACCTCATACCCGTGAGTGGTCATGAACCACTCAATACCCT
 CTCCTCTGGAGGCTTCAGAGGAACTGCATTGAAATAAAAGCCGCATTGC (SEQ ID
 NO:19)

Translation:

30 MKLTCVLIIAVLFLTACQLITAETYSRGEQMHRALRSTDKN SKLTRQCTPNNGGSCSRHF
 HCCSLYCNKSTGVCIATSYP (SEQ ID NO:20)

Toxin Sequence:

35 Xaa2-Cys-Thr-Xaa3-Asn-Gly-Gly-Ser-Cys-Ser-Arg-His-Phe-His-Cys-Cys-Ser-Leu-Xaa5-Cys-
 Asn-Lys-Ser-Thr-Gly-Val-Cys-Ile-Ala-Thr-Ser-Xaa5-Xaa3-^ (SEQ ID NO:21)

40 **Name:** Ar6.4

Species: arenatus

Cloned: Yes

DNA Sequence:

45 GGATCCATGAAACTGACGTGCATGGTGATTATCGCCGTGCTGTTCTGACGGCCTGT
 CAACTCATTACAGCTGAGACTTACTCCAGAGGTGAGCAGAAGCACCATGCTCTGAG
 GTCAACTGACAAAACTCCAAGTTGACCAGGACATGCAACACTCCCACCGAATATT

GTACTTTGCATCAACACTGCTGCAGCGGCTACTGCCATAAAACAATCCAGGCATGTT
CATAATACCGGTGAGTGGTCATGAACCACTCAATACCCTCTCCTCTGGAGGCTTCAG
AGGAACTGCATTGAAATAAAACCGCATTACAAAAAAAAAAAAAAAAAAAAA (SEQ ID
NO:22)

5

Translation:

MKLTCMVIIAVLFLTACQLITAETYSRGEQKHHALRSTDKNSKLTRTCNTPTEYCTLHQ
HCCSGYCHKTIQACS (SEQ ID NO:23)

10

Toxin Sequence:

Thr-Cys-Asn-Thr-Xaa3-Thr-Xaa1-Xaa5-Cys-Thr-Leu-His-Gln-His-Cys-Cys-Ser-Gly-Xaa5-
Cys-His-Lys-Thr-Ile-Gln-Ala-Cys-Ser-^ (SEQ ID NO:24)

15

Name: Ar6.6
Species: arenatus
Cloned: Yes

20

DNA Sequence:

GGATCCATGAAACTGACGTGTATGGTGATCATCGCCGTACTGTTTCCTGACGGCCTGT
CAACTCATTACAGCTGAGACTTACTCCAGAGGTAAGCAGATGCACCGCGCTCTGAG
GTCAACTGACAAAACTCCCAGTTGACCAGGGAATGCACACCTCCCGGTGGAGCTT
GTGGTTTACCTACACACTGCTGCGGGTTTTGCGATACTGCAAACAACAGATGTCTGT
AAAGCTGGTCTGGCGTCTGATATTCCCCTTCTGTGCTCTATCCTCTTTGGCCTGAGTC
ATCCGTACCTGTGAGTGGTCATGAACACTCAATACCCTCTCCTCTGGAGGCTTCAG
AGGAACTACAATGAAATAAAACCCGCATTGCAGAGAAAAAAAAAAAAAAAAAAAAA
(SEQ ID NO:25)

25

Translation:

30 MKLTCMVIIAVLFLTACQLITAETYSRGKQMHRLRSTDKNSQLTRECTPPGGACGLPT
HCCGFCDTANNRCL (SEQ ID NO:26)

Toxin Sequence:

35 Xaa1-Cys-Thr-Xaa3-Xaa3-Gly-Gly-Ala-Cys-Gly-Leu-Xaa3-Thr-His-Cys-Cys-Gly-Phe-Cys-
Asp-Thr-Ala-Asn-Asn-Arg-Cys-Leu-^ (SEQ ID NO:27)

40

Name: Ar6.7
Species: arenatus
Cloned: Yes

DNA Sequence:

45 GGATCCATGAAACTGACGTGCGTGGTGATTATCGCCGTGCTGTTTCCTGACGGCCTGT
CAACTCATTACAGCTGAGACTTACTCCAGAGGTGAGCAGAATCACCATGTTCTGAG
GTCAACTGACAAAACTCCAAGTTGACCAGGACATGCAAACTCCCACTGAATATT
GTACTTTGCATCAACACTGCTGCAGCGGCCACTGCCATAAAACAATCCAGGCATGT
GCATAATACCGGTGGGTGGTCATGAACCACTCAATACCCTCTCCTCTGGAGGCTTCA

GAGGAACTGCATTGAAATAAAACCGCATTGCAATGAANAAAAAAAAAAAAAAAAAAAA
 AAAAAAAAA (SEQ ID NO:28)

Translation:

MKLTCVVIIAVLFLTACQLITAETYSRGEQNHVLRSTDKNSKLTRTCNTPTEYCTLHQ
 HCCSGHCHKTIQACA (SEQ ID NO:29)

Toxin Sequence:

Thr-Cys-Asn-Thr-Xaa3-Thr-Xaa1-Xaa5-Cys-Thr-Leu-His-Gln-His-Cys-Cys-Ser-Gly-His-Cys-
 His-Lys-Thr-Ile-Gln-Ala-Cys-Ala-^ (SEQ ID NO:30)

Name: Ar6.8
Species: arenatus
Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGTGTGGTGATCATCGCCGTGCTGTTCCCTGACGGCCTGT
 CAACTCACTACAGGTGAGCAGAAGGACCATGCTCTGAGGTCAACTGACAAAACTC
 CAAGTTGACTAGGCAGTGCTCGCCTATCGGTGGATATTGTACTCTTCATATTCACTG
 CTGCAGCAACCATTGCATTAAACCTATCGGCCGATGTGTGGCAACCTGATACCCGTG
 CGTGGTCATGAACCCCTCAATACCCTCTCCTCTGGAGGCTTCAGAGGAACTGCATTG
 AAATAAAACCGCATTGCAATAAAAAAAAAAAAAAAAAAAAA (SEQ ID NO:31)

Translation:

MKLTCVVIIAVLFLTACQLTTGEQKDHALRSTDKNSKLTRQCSPIGGYCTLHHCCSNHC
 IKPIGRCVAT (SEQ ID NO:32)

Toxin Sequence:

Xaa2-Cys-Ser-Xaa3-Ile-Gly-Gly-Xaa5-Cys-Thr-Leu-His-Ile-His-Cys-Cys-Ser-Asn-His-Cys-Ile-
 Lys-Xaa3-Ile-Gly-Arg-Cys-Val-Ala-Thr-^ (SEQ ID NO:33)

Name: Ar6.9
Species: arenatus
Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGCGTGGTGATCATCGCCGTGCTGTTCCCTGACGGCCTGT
 CAACTCACTACAGGTGAGCAGAAGGACCATGCTCTGAGGTCAACTGACAAAACTC
 CAAGTTGACTAGGCAGTGCTTGCTAACGGTGGATATTGTACTCTTCATATTCACTG
 CTGCAGCGACCATTGCATTAAACCTATCGACCGATGTGTGGCAACCTGATACCCGG
 GCGTGGTCATGAACCCCTCAATACCCTCTCCTCTGGAGGCTTCAGAGGAACTGCATT
 GAAATAAAACCGCATTACAAAAAAAAAAAAAAAAAAAA (SEQ ID NO:34)

Translation:

MKLTCVVIIAVLFLTACQLTTGEQKDHALRSTDKNSKLTRQCLPNGGYCTLHIHCCSDH
CIKPIDRCVAT (SEQ ID NO:35)

5 **Toxin Sequence:**

Xaa2-Cys-Leu-Xaa3-Asn-Gly-Gly-Xaa5-Cys-Thr-Leu-His-Ile-His-Cys-Cys-Ser-Asp-His-Cys-Ile-Lys-Xaa3-Ile-Asp-Arg-Cys-Val-Ala-Thr-^ (SEQ ID NO:36)

10 **Name:** Ay6.1
Species: aurisiacus
Cloned: Yes

DNA Sequence:

15 ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGTCAACTC
ATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTTCCTGAGCTCGGCCAC
CAAACCTCTCCATGTCGACTCGCTGCAAGGGTAAAGGAAAACCATGCAGTAGGATTT
CGTATAACTGCTGCACCGGTTCTTGCAGATCAGGTAAATGTGGCTGATCCAGCGCCT
20 GATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCTTACCTGAGAGTG
GTCATGAACCACTCATCACCTGCTCCTCTGGAGGCCCCAGAGGAGCTACATTGAAAT
AAAAGTCGCATTGCAAAAAAAAAAAAAAAAAAAAAA (SEQ ID NO:37)

Translation:

25 MKLTCVVIVAVLLLACQLITADDSRGTQKHRSLSATKLSMSTRCKGKGKPCSRISYN
CCTGSCRSKGKCG (SEQ ID NO:38)

Toxin Sequence:

30 Cys-Lys-Gly-Lys-Gly-Lys-Xaa3-Cys-Ser-Arg-Ile-Ser-Xaa5-Asn-Cys-Cys-Thr-Gly-Ser-Cys-Arg-Ser-Gly-Lys-Cys-# (SEQ ID NO:39)

35 **Name:** Ay6.2
Species: aurisiacus
Cloned: Yes

DNA Sequence:

40 ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGTCAACTC
ATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTTCCTGAGGTCTGAAGAC
CAAACCTCTCCATGTCGACTGGCTGCATGGAAGCCGGATCTTATTGCGGCTCTACTAC
GAGAATCTGCTGCGGTTTTTTCGCTTATTTTCGGCAAAAAATGTATTGACTATCCCAG
CAACTGATCTTCCCCCTACTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCTTACCTGA
GAGTGGTCATGAACCACTCATCACCTGCTCCTCTGGAGGCCCCAGAGGAGCTACATT
GAAATAAAATCGCATTGCTAAAAAAAAAAAAAAAAAAAAA (SEQ ID NO:40)

45 **Translation:**

CCGFCA YFGKKCIDYPSN (SEQ ID NO:41)

Toxin Sequence:

Cys-Met-Xaa1-Ala-Gly-Ser-Xaa5-Cys-Gly-Ser-Thr-Thr-Arg-Ile-Cys-Cys-Gly-Phe-Cys-Ala-Xaa5-Phe-Gly-Lys-Lys-Cys-Ile-Asp-Xaa5-Xaa3-Ser-Asn-^ (SEQ ID NO:42)

Name: Ay6.3
Species: aurisiacus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTTCCCTGAGCTCGGCCACCAAACCTCTCCATGTCGACTCGCTGCAAGGCTAAAGGA
 AAACCATGCAGTAGGATTGCGTATAACTGCTGCACCGGTTCTTGCAGATCAGGTAA
 ATGTGGCTGATCCAGTGCCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGA
 GTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTGCTCCTCTGGAGGCC
 CAGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:43)

Translation:

MKLTCVVIVAVLLLACQLITADDSRGTQKHRSLSSATKLSMSTRCKAKGKPCSRIAYN
 CCTGSCRSKGKCG (SEQ ID NO:44)

Toxin Sequence:

Cys-Lys-Ala-Lys-Gly-Lys-Xaa3-Cys-Ser-Arg-Ile-Ala-Xaa5-Asn-Cys-Cys-Thr-Gly-Ser-Cys-Arg-Ser-Gly-Lys-Cys-# (SEQ ID NO:45)

Name: Ay6.4
Species: aurisiacus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGACCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGGAGCATC
 GTGCCCTGAGGTCGAAGACAAAACCTCTCCATGTAACTTTGCGCTGCGCATCTTACG
 GAAAACCTTGTGGTATTGACAACGACTGCTGCAATGCATGCGATCCAGGAAGAAAT
 ATATGTACGTAGCTGATCCAGCGCCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCT
 GCCCGAGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTGCTCCCTGGA
 GGCCTCAGAGGAGCTACAATGAAATAAAAGCCGCATTGC (SEQ ID NO:46)

Translation:

MKLTCVVIVAVLLLTTCLITADDSRGTQEHRLRSKTKLSMLTLRCASYGKPCGIDND
 CCNACDPGRNICT (SEQ ID NO:47)

Toxin Sequence:

Cys-Ala-Ser-Xaa5-Gly-Lys-Xaa3-Cys-Gly-Ile-Asp-Asn-Asp-Cys-Cys-Asn-Ala-Cys-Asp-Xaa3-

Gly-Arg-Asn-Ile-Cys-Thr-^ (SEQ ID NO:48)

Name: Bu6.1
Species: bullatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGCGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAGCTCATTACAGCTGAAGACTCCAGAGGTACGCATGAGCATC
 TTGCCCTGAAGTCGACCTCCAAAGTCTCCAAGTCGACTAGCTGCATGGAAGCCGGA
 TCTTATTGCGGACCTGCTACTACGAAAATCTGCTGCGATTTTGCAGTCCATTCAGC
 GATAGATGTATGAACAATCCCAACAATTGATCTTCCCCCTTGTGTGCTCCATCCTTT
 CTGCCTGAGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCT
 GGAGGCTTCAGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:49)

Translation:

MKLTCVAIVAVLLLTAQLITAEDSRGTHEHLALKSTSKVSKSTSCMEAGSYCGPATTK
 ICCDFCSPFSDRCMNNPNN (SEQ ID NO:50)

Toxin Sequence:

Ser-Thr-Ser-Cys-Met-Xaa1-Ala-Gly-Ser-Xaa5-Cys-Gly-Xaa3-Ala-Thr-Thr-Lys-Ile-Cys-Cys-
 Asp-Phe-Cys-Ser-Xaa3-Phe-Ser-Asp-Arg-Cys-Met-Asn-Asn-Xaa3-Asn-Asn-^ (SEQ ID NO:51)

Name: Bu6.2
Species: bullatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAGCTCATTACAGCTGAAGACTCCAGAGGTACGCAGTTGCATC
 GTGCCCTGAGGAAGGCCACCAAACACCCTGTGTGCGACTCGCTGCATTACTCCAGGA
 ACACGATGTAAGGTTCCGAGCCAATGCTGCAGAGGTCCTTGCAAGAACGGTCGTTG
 TACTCCATCCCCTTCTGAATGGTAAATGTGGTTGATCCAGCGCCTGATCTTCCCCCTT
 CGTCGTGCTCCATCCTTTTCTGCCTGAGTCCTCCTTACCTGAGAGTGGTCATGAACC
 ACTCATCACCTACTCCCCTGGAGGCTTCAGAGGAGCTACATTGAAATAAAAGCCGC
 ATTGC (SEQ ID NO:52)

Translation:

MKLTCVVIVAVLLLTAQLITAEDSRGTQLHRALRKATKHPVSTRCITPGTRCKVPSQC
 CRGPCKNGRCTPSPSEW (SEQ ID NO:53)

Toxin Sequence:

Cys-Ile-Thr-Xaa3-Gly-Thr-Arg-Cys-Lys-Val-Xaa3-Ser-Gln-Cys-Cys-Arg-Gly-Xaa3-Cys-Lys-
 Asn-Gly-Arg-Cys-Thr-Xaa3-Ser-Xaa3-Ser-Xaa1-Xaa4-^ (SEQ ID NO:54)

Name: Bu6.3
Species: bullatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGCGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAGCTCATTACAGCTGAGGACTCCAGAGATACGCAGAAGCATC
 GTGCCCTGAGGTCGGACACCAAACCTCTCCATGTTGACTTTGCGCTGCGCAACTTACG
 GAAAACCTTGTGGTATTCAAAACGACTGCTGCAATACATGCGATCCAGCCAGAAGG
 ACATGTACGTAGCTGATCCGGCGTCTTGATCCTCCGCTTCTGTGCTCCATCTTTTCTG
 CCTGAGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGGA
 GGCTTTAGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:55)

Translation:

MKLTCVAIVAVLLLTACQLITAEDSRDTQKHRALRSDTKLSMLTLRCATYGKPCGIQND
 CCNTCDPARRTCT (SEQ ID NO:56)

Toxin Sequence:

Cys-Ala-Thr-Xaa5-Gly-Lys-Xaa3-Cys-Gly-Ile-Gln-Asn-Asp-Cys-Cys-Asn-Thr-Cys-Asp-Xaa3-
 Ala-Arg-Arg-Thr-Cys-Thr-^ (SEQ ID NO:57)

Name: Bu6.4
Species: bullatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGCGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAGCTCATTACAGCTGAAGACTCCAGAGGTACGCAGTTGCATC
 GTGCCCTGAGGAAGACCACCAAACCTCTCCTTGTGCGACTCGCTGCAAGGGTCCAGGA
 GCATCATGTATAAGGATTGCGTATAACTGCTGCAAGTATTCTTGCAGAAATGGTAAA
 TGTGGCTGATCCAGCGCCTGATCTTCCCCCTTGTGTGCTCCATCCTTTTCTGCCTGAG
 TCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGGAGGCTTC
 AGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:58)

Translation:

MKLTCVAIVAVLLLTACQLITAEDSRGTQLHRALRKTTKLSLSTRCKGPGASCIRIAYNC
 CKYSCRNGKCG (SEQ ID NO:59)

Toxin Sequence:

Cys-Lys-Gly-Xaa3-Gly-Ala-Ser-Cys-Ile-Arg-Ile-Ala-Xaa5-Asn-Cys-Cys-Lys-Xaa5-Ser-Cys-
 Arg-Asn-Gly-Lys-Cys-# (SEQ ID NO:60)

Name: Bu6.5
Species: bullatus
Cloned: Yes

DNA Sequence:

ATCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTC
 CTGACGGCCTGTCAGCTCATTACAGCTGAAGACTCCAGAGGTACGCATGAGCATCTT
 GCCCTGAAGTCGACCTCCAAAGTCTCCAAGTCGACTAGCTGCATGGCAGCCGGATC
 TTATTGCGGACCTGCTACTACGAATATCTGCTGCGATTTTTGCAGTCCATTCAGCGA
 TAGATGTATGAAAAAGCCCAACAATTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCT
 GCCTGAGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGG
 AGGCTTCAGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:61)

Translation:

MKLTCVVIVAVLLLTACQLITAEDSRGTHEHLALKSTSKVSKSTSCMAAGSYCGPATN
 ICCDFCSPFSDRCMKKPNN (SEQ ID NO:62)

Toxin Sequence:

Ser-Thr-Ser-Cys-Met-Ala-Ala-Gly-Ser-Xaa5-Cys-Gly-Xaa3-Ala-Thr-Thr-Asn-Ile-Cys-Cys-
 Asp-Phe-Cys-Ser-Xaa3-Phe-Ser-Asp-Arg-Cys-Met-Lys-Lys-Xaa3-Asn-Asn-^ (SEQ ID NO:63)

Name: Bu6.6
Species: bullatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAGCTCATTATAGCTGAGGACTCCAGAGGTACGCAGTTGCATCG
 TGCCCTGAGGAAGGCCACCAAACTCTCCGTGTGCGACTCGCTGCAAGAGTAAAGGAT
 CATCATGTGCATAGGACTTCGTATGACTGCTGCACGGGTTCTTGCAGAAATGGTAGAT
 GTGGCTGATCCAGCGCCTGATCTTCCCCCTTCTGTGCTCCATCCTTTTCTGCCTGAGT
 CCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGGAGGCTTCA
 GAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:64)

Translation:

MKLTCVVIVAVLLLTACQLIAEDSRGTQLHRALRKATKLSVSTRCKSKGSSCHRYSYD
 CCTGSCRNGRCG (SEQ ID NO:65)

Toxin Sequence:

Cys-Lys-Ser-Lys-Gly-Ser-Ser-Cys-His-Arg-Thr-Ser-Xaa5-Asp-Cys-Cys-Thr-Gly-Ser-Cys-Arg-
 Asn-Gly-Arg-Cys-# (SEQ ID NO:66)

Name: Ca6.4
Species: characteristicus
Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGCGTGGTGATCATCGCCGTGCTGTTCCCTGACGGCCTGT
 CAACTCATTACAGGTGAGCAGAAGGACCATGCTCTGAGGTCAACTGACAAAACTC
 5 CAAGTTGACTAGGCAGTGCTCGGCTAACGGTGGATCTTGTACTCGTCATTTTCACTG
 CTGCAGCCTCTATTGCAATAAAGATTCCAGTGTATGTGTGGCAACCTCATAACCCGTG
 AGTGGCCATGAACCCCTCAATACCCTCTCCTCTGGAGGCTTCAGAGGAACTGCATTG
 AAATAAAACCGCATTACAAAAA (SEQ ID NO:67)

Translation:

MKLTCVVIIAVLFLTACQLITGEQKDHALRSTDKNSKLTRQCSANGGSCTRHFHCCSLY
 CNKDSSVCVATSY (SEQ ID NO:68)

Toxin Sequence:

Xaa2-Cys-Ser-Ala-Asn-Gly-Gly-Ser-Cys-Thr-Arg-His-Phe-His-Cys-Cys-Ser-Leu-Xaa5-Cys-
 Asn-Lys-Asp-Ser-Ser-Val-Cys-Val-Ala-Thr-Ser-Xaa5-Xaa3-^ (SEQ ID NO:69)

Name: C6.1

Species: catus

Cloned: Yes

DNA Sequence:**Translation:**

CKSTGASCRRTSYDCCTGSCRSGRCG (SEQ ID NO:70)

Toxin Sequence:

Cys-Lys-Ser-Thr-Gly-Ala-Ser-Cys-Arg-Arg-Thr-Ser-Xaa5-Asp-Cys-Cys-Thr-Gly-Ser-Cys-Arg-
 30 Ser-Gly-Arg-Cys-# (SEQ ID NO:71)

Name: C6.4

Species: catus

Cloned: Yes

DNA Sequence:

TCGACTCGCTGCCAGGGTAGAGGAGCATCATGTGCGTAAGACTATGTATAACTGCTG
 CAGCGGTTCTTGCAACAGAGGTAGTTGTGGCTGATCCGGCGCCTGATCTTCCCCCTT
 40 CCGTGCTCTATCCTTTTCTGCCTGATTCCTCCTTACCTGAGAGCGGTCATGAACCACT
 CATCACCTGCTCCTCTGGAGGCCTCAGAGGAGCTACATTGAAATAAAAGCCGCATT
 GC (SEQ ID NO:72)

Translation:

STRCQGRGASCRKTMYNCCSGSCNRGSCG (SEQ ID NO:73)

Toxin Sequence:

Cys-Gln-Gly-Arg-Gly-Ala-Ser-Cys-Arg-Lys-Thr-Met-Xaa5-Asn-Cys-Cys-Ser-Gly-Ser-Cys-Asn-Arg-Gly-Ser-Cys-# (SEQ ID NO:74)

5 **Name:** C6.5
Species: catus
Cloned: Yes

DNA Sequence:

10 TCGACACGCTGCTTGCCTGCCGGAGAGTCTTGCCTTTTATAGTAGGATTAGATGCTGC
 GGTACTTGCAGTTCAGTCTTAAAGTCATGTGTGAGCTGATCCAGCTGCTGATCTTCC
 TCCTCCTGTGCTCCATCCTTTTCTGCCTGAGTCCTCCTTATCTGAGAGTGGTCATGAA
 CCACTCACCACCTACTCTTCTGGAGGCTTCAGAGGAGCTACAGTGAAATAAAAGCC
 GCATTGC (SEQ ID NO:75)

Translation:

STRCLPAGESCLFSRIRCCGTCSSVLKSCVS (SEQ ID NO:76)

Toxin Sequence:

20 Cys-Leu-Xaa3-Ala-Gly-Xaa1-Ser-Cys-Leu-Phe-Ser-Arg-Ile-Arg-Cys-Cys-Gly-Thr-Cys-Ser-
 Ser-Val-Leu-Lys-Ser-Cys-Val-Ser-^ (SEQ ID NO:77)

25 **Name:** C6.6
Species: catus
Cloned: Yes

DNA Sequence:

30 TCGACACGCTGCCAGGGTAGAGGAGGACCATGTACTAAGGCTGTGTTTAACTGCTG
 CAGCGGTTCTTGCAACAGAGGTAGATGTGGCTGATCCAGCGCCTGATCTTCCCCCTT
 CTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCTTACTGAGAGTAGTCATGAACCACTC
 ATCACCTACTCCTCTGGAGGCCTCAGAGAGCTACATTGAAATAAAAGCCGCATTGC
 (SEQ ID NO:78)

Translation:

35 STRCQGRGGPCTKAVFNCCSGSCNRGRCG (SEQ ID NO:79)

Toxin Sequence:

40 Cys-Gln-Gly-Arg-Gly-Gly-Xaa3-Cys-Thr-Lys-Ala-Val-Phe-Asn-Cys-Cys-Ser-Gly-Ser-Cys-
 Asn-Arg-Gly-Arg-Cys-# (SEQ ID NO:80)

45 **Name:** C6.7
Species: catus
Cloned: Yes

DNA Sequence:

TTAACTTTGCGCTGCGCAACTTACGGAAAACCTTGTGGTATTCAAAACGACTGCTGC
AATACATGCGATCCAGCCAGAAAGACATGTACGTAGCTGATCCGGCGTCTGATCTC
CCCCCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCTTACCTGAGAGTGGTCATG
AACCACCTCATCACCTGCTCCTCTGGAGGCCTCGGGGGAGCTACATTGAAATAAAAG
CCGCATTGC (SEQ ID NO:81)

Translation:

LTLRCATYGKPCGIQNDCNTCDPARKTCT (SEQ ID NO:82)

10 **Toxin Sequence:**

Cys-Ala-Thr-Xaa5-Gly-Lys-Xaa3-Cys-Gly-Ile-Gln-Asn-Asp-Cys-Cys-Asn-Thr-Cys-Asp-Xaa3-
Ala-Arg-Lys-Thr-Cys-Thr-^ (SEQ ID NO:83)

15 **Name:** C6.8

Species: catus

Cloned: Yes

DNA Sequence:

TCGACTCGCTGCCGGGGTAGAGGAGGACCATGTACTAAGGCTATGTTTAACTGCTG
CAGCGGTTCTTGCAACAGAGGTAGATGTGGCTGATCCAGCGCCTGATCTTCCCCCTT
CTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCTTAACTGAGAGTAGTCATGAACCACT
CATCACCTACTCCTCTGGAGGCCTCAGAGAAGCATCATTGAAATAAAAGCCGCATT
GC (SEQ ID NO:84)

Translation:

STRCRGRGPCTKAMFNCCSGSCNRGRGCG (SEQ ID NO:85)

Toxin Sequence:

Cys-Arg-Gly-Arg-Gly-Gly-Xaa3-Cys-Thr-Lys-Ala-Met-Phe-Asn-Cys-Cys-Ser-Gly-Ser-Cys-
Asn-Arg-Gly-Arg-Cys-# (SEQ ID NO:86)

Name: Cr6.1

Species: circumcised

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
CCTGACGACCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGGAGCATC
GTGCCCTGAGGTTCGGACACCAAACTCCCCATGTCGACTCGCTGCAAGGGTAAAGGA
GCATCATGTTCGTAAGACTATGTATAACTGCTGCAGCGGTTCTTGCAGCAACGGTAGA
TGTGGCTGATCCAGCGCCTGATCTTCCCCCTTCTGCTGCTCTATCCTTTTCTGCCTGA
GTCCTCCTTACCTGAGAGCTGGTCATGAACCACTCATCACCTGCTCCTCTGGAGGCC
CAGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:87)

Translation:

MKLTCVVIVAVLLLTTTCQLITADDSRGTQEHRLRSDTKLPMSTRCKGKGASCRKTMYNCCSGSCSNGRCG (SEQ ID NO:88)

Toxin Sequence:

5 Cys-Lys-Gly-Lys-Gly-Ala-Ser-Cys-Arg-Lys-Thr-Met-Xaa5-Asn-Cys-Cys-Ser-Gly-Ser-Cys-Ser-Asn-Gly-Arg-Cys-# (SEQ ID NO:89)

Name: Cr6.2

10 **Species:** circumcised

Cloned: Yes

DNA Sequence:

15 ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
CCTGACGACCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
GTGCCCTGAGGTTCGGCCACCAAAGTCTCCAAGTCGACTAGCTGCATGGAAGCCGGA
TCTTATTGCCGCTCTACTACGAGAACCTGCTGCGGTTATTGCTCTTATTTTCAGCAAAA
AATGTATTGACTTTCCAGCAACTGATCTTCCCCCTACTGTGCTCTATCCTTTTCTGC
20 CTGAGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGGA
GGCCCAGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:90)

Translation:

25 MKLTCVVIVAVLLLTTTCQLITADDSRGTQKHLRALRSATKVSSTSCMEAGSYCRSTTRT
CCGYCSYFSKKCIDFPSN (SEQ ID NO:91)

Toxin Sequence:

30 Ser-Thr-Ser-Cys-Met-Xaa1-Ala-Gly-Ser-Xaa5-Cys-Arg-Ser-Thr-Thr-Arg-Thr-Cys-Cys-Gly-
Xaa5-Cys-Ser-Xaa5-Phe-Ser-Lys-Lys-Cys-Ile-Asp-Phe-Xaa3-Ser-Asn-^ (SEQ ID NO:92)

Name: Cr6.3

Species: circumcised

Cloned: Yes

DNA Sequence:

35 ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
CCTGACGACCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGGAGCATC
GTGCCCTGAGGTTCGGACACCAAACCTCCCATGTCGACTCGCTGCAAGAGTAAAGGA
GCAAAATGTTCAAGGCTTATGTATGACTGCTGCAGCGGTTCTTGACAGCAGGTACTCA
40 GGTAGATGTGGCTGATCCAGCGCCTGATCTTCCCCCTTCTGCTGCTCTATCCTTTTCT
GCCTGAGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGG
AGGCCAGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:93)

Translation:

45 MKLTCVVIVAVLLLTTTCQLITADDSRGTQEHRLRSDTKLPMSTRCKSKGAKCSRLMY
DCCSGSCSRYSGRGCG (SEQ ID NO:94)

Toxin Sequence:

Cys-Lys-Ser-Lys-Gly-Ala-Lys-Cys-Ser-Arg-Leu-Met-Xaa5-Asp-Cys-Cys-Ser-Gly-Ser-Cys-Ser-Arg-Xaa5-Ser-Gly-Arg-Cys-# (SEQ ID NO:95)

5

Name: Cr6.4
Species: circumcised
Cloned: Yes

10 **DNA Sequence:**

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGACCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTTCCCTGACGTCGGCCACCAAAGTCTCCAAGTCGACTGGCTGCATGAAAGCCGGA
 TCTTATTGCCGCTCTACTACGAGAACTTGCTGCGGTTATTGCGCTTATTTTCGGCAAA
 AAATGTATTGACTATCCCAGCAACTGATCTTCCCCCTACTGTGCTCTATCCTTTTCTG
 CCTAAGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGG
 AGGCCAGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:96)

15

Translation:

MKLTCVVIVAVLLLTTCLITADDSRGTQKHRSLTSATKVSKSTGCMKAGSYCRSTTRT
 CCGYCAIFGKKCIDYPSN (SEQ ID NO:97)

20

Toxin Sequence:

Ser-Thr-Gly-Cys-Met-Lys-Ala-Gly-Ser-Xaa5-Cys-Arg-Ser-Thr-Thr-Arg-Thr-Cys-Cys-Gly-
 Xaa5-Cys-Ala-Xaa5-Phe-Gly-Lys-Lys-Cys-Ile-Asp-Xaa5-Xaa3-Ser-Asn-^ (SEQ ID NO:98)

25

Name: Cn6.1
Species: consors
Cloned: Yes

30

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGTCAACTC
 CTCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGAAGTCTTACAC
 CAAACTCTCCATGTAACTTTGCGCTGCGCATCTTACGGAAAACCTTGTGGTATTGA
 CAACGACTGCTGCAATACATGCGATCCAGCCAGAAAGACATGTACGTAGCTGATCC
 GCGTCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCTTACCT
 GAGAGTGGTCATGAACCACTCATCACCTAGCTCCTCTGGAGGCTTCAGAGGAGCTA
 CAATGAAATAAAAGCGCATTGC (SEQ ID NO:99)

35

Translation:

MKLTCVVIVAVLLLTACQLLTADDSRGTQKHRALKSYTKLSMLTLRCASYGKPCGIDN
 DCCNTCDPARKTCT (SEQ ID NO:100)

40

Toxin Sequence:

Cys-Ala-Ser-Xaa5-Gly-Lys-Xaa3-Cys-Gly-Ile-Asp-Asn-Asp-Cys-Cys-Asn-Thr-Cys-Asp-Xaa3-
 Ala-Arg-Lys-Thr-Cys-Thr-^ (SEQ ID NO:101)

45

Name: Cn6.2
Species: consors
Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGTCAACTC
 CTCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGAGGTCGGACAC
 CAAACTCTCCATGTGCGACTCGCTGCAAGGGTACAGGAAAACCATGCAGTAGGATTG
 CGTATAACTGCTGCACCGGTTCTTGCAGATCAGGTAAATGTGGCTGATCCAGCGCCT
 GATCTCCCCC (SEQ ID NO:102)

Translation:

MKLTCVVIVAVLLLTACQLLTADDSRGTQKHRALRSDTKLSMSTRCKGTGKPCSRIAY
 NCCTGSCRSGKCG (SEQ ID NO:103)

Toxin Sequence:

Cys-Lys-Gly-Thr-Gly-Lys-Xaa3-Cys-Ser-Arg-Ile-Ala-Xaa5-Asn-Cys-Cys-Thr-Gly-Ser-Cys-
 Arg-Ser-Gly-Lys-Cys-# (SEQ ID NO:104)

Name: Cn6.3
Species: consors
Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGTCAACTC
 ATCACAGCTGATGACTCCAAAGGTACGCAGAAGCATCGTTCCCTGAGGTCGACCAC
 CAAAGTCTCCAAGGCGACTGACTGCATTGAAGCCGGAAATTATTGCGGACCTACTG
 TTATGAAAATCTGCTGCGGCTTTTGCAGTCCATACAGCAAAATATGTATGAACTATC
 CCCAAAATTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCTTAC
 CTGAGAGTGGTCATGAACCACTCATCACCTCGTCCC (SEQ ID NO:105)

Translation:

MKLTCVVIVAVLLLTACQLITADDSKGTQKHRSLRSTTKVSKATDCIEAGNYCGPTVM
 KICCGFCSPYSKICMNYPQN (SEQ ID NO:106)

Toxin Sequence:

Ala-Thr-Asp-Cys-Ile-Xaa1-Ala-Gly-Asn-Xaa5-Cys-Gly-Xaa3-Thr-Val-Met-Lys-Ile-Cys-Cys-
 Gly-Phe-Cys-Ser-Xaa3-Xaa5-Ser-Lys-Ile-Cys-Met-Asn-Xaa5-Xaa3-Gln-Asn-^ (SEQ ID
 NO:107)

Name: Cn6.4
Species: consors
Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGTCAACTC
 CTCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGAGGTCGGACAC
 5 CAAACTCTCCATGTCTGACTCGCTGCAAAGGTAAAGGAGCATCATGTACAAGGCTTA
 TGTATGACTGCTGCCACGGTTCTTGCAGCAGCAGCAAGGGTAGATGTGGCTGATCC
 GGCGCCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCTTACCT
 GAGAGGTGGTCATGAACCACTCATCACCTGCTCCCCTG (SEQ ID NO:108)

Translation:

MKLTCVVIVAVLLLACQLLTADDSRGTQKHRALRSDTKLSMSTRCKGKGASCTRLM
 YDCCHGSCSSSKGRCG (SEQ ID NO:19)

Toxin Sequence:

15 Cys-Lys-Gly-Lys-Gly-Ala-Ser-Cys-Thr-Arg-Leu-Met-Xaa5-Asp-Cys-Cys-His-Gly-Ser-Cys-
 Ser-Ser-Ser-Lys-Gly-Arg-Cys-# (SEQ ID NO:110)

Name: Cn6.5

Species: consors

Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGCATGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGT
 25 CAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGAGGTC
 GGACACCAAACCTCTCCATGTCAACTCGCTGCAAGGGTAAAGGAGCATCATGTCATA
 GGAATTTCGTATGACTGCTGCACCGGTTCTTGCAACAGAGGTAAATGTGGCTGATCCG
 GCGCCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCATCCATACCTG
 TGCTCGAG (SEQ ID NO:111)

Translation:

MKLTCMVIVAVLLLACQLITADDSRGTQKHRALRSDTKLSMSTRCKGKGASCHRTSY
 DCCTGSCNRGKCG (SEQ ID NO:112)

Toxin Sequence:

35 Cys-Lys-Gly-Lys-Gly-Ala-Ser-Cys-His-Arg-Thr-Ser-Xaa5-Asp-Cys-Cys-Thr-Gly-Ser-Cys-Asn-
 Arg-Gly-Lys-Cys-# (SEQ ID NO:113)

Name: Cn6.6

Species: consors

Cloned: Yes

DNA Sequence:

45 GGATCCATGAAACTGACGTGCGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGT
 CAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGAAGTC
 GGACACCAAACCTCTCCATGTAACTTTGCGCTGCGCATCTTACGGAAAACCTTGTGG

TATTTACAACGACTGCTGCAATACATGCGATCCAGCCAGAAAGACATGTACGTAGC
TGATCCGGCGTCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCATCC
ATACCTGTGCTCGAG (SEQ ID NO:114)

5 **Translation:**
MKLTCVVIVAVLLLACQLITADDSRGTQKHRALKSDTKLSMLTLRCASYGKPCGIYN
DCCNTCDPARKTCT (SEQ ID NO:115)

10 **Toxin Sequence:**
Cys-Ala-Ser-Xaa5-Gly-Lys-Xaa3-Cys-Gly-Ile-Xaa5-Asn-Asp-Cys-Cys-Asn-Thr-Cys-Asp-
Xaa3-Ala-Arg-Lys-Thr-Cys-Thr-^ (SEQ ID NO:116)

Name: Cn6.7
Species: consors
Cloned: Yes

DNA Sequence:
GGATCCATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGT
CAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGAGGTC
GGACACCAAACCTCTCCATGTCGACTCGCTGCAAGGGTACAGGAAAACCATGCAGTA
GGGTTGCGTATAACTGCTGCACCGGTTCTTGCAAGATCAGGTAAATGTGGCTGATCCA
GTGCCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCTTACCTG
AGAGTGGTCATGAACCACTCATCACCTGCTCCTCTGGAGGCTTCAGAGGAGCTACAT
TGAAATAAAAGCCGCATTGCANTGNANAAAAANNNNNNNNNNNNNNNNNNNNNNNNN
NNNNNNNNNNNNNNNNNNNGGAAAAAAAAAAAAAAAAAAAAAAAAA (SEQ ID NO:117)

Translation:
MKLTCVVIVAVLLLACQLITADDSRGTQKHRALRSDTKLSMSTRCKGTGKPCSRVAY
NCCTGSCRSKGKCG (SEQ ID NO:118)

Toxin Sequence:
Cys-Lys-Gly-Thr-Gly-Lys-Xaa3-Cys-Ser-Arg-Val-Ala-Xaa5-Asn-Cys-Cys-Thr-Gly-Ser-Cys-
Arg-Ser-Gly-Lys-Cys-# (SEQ ID NO:119)

Name: Cn6.8
Species: consors
Cloned: Yes

DNA Sequence:
GGATCCATGAAACTGACGTGCATGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGT
CAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTTCCCTGAGGTC
GACCACCAAAGTCTCCAAGTCGACTAGCTGCATGAAAGCCGGGTCTTATTGCCGCTC
TACTACGAGAACCTGCTGCGGTTATTGCGCTTATTTTCGGCAAATTTTGTATTGACTTT
CCCAGCAACTGATCTTCCCCCTACTGTGCTCTATCCTTTTCTGCCTCTGCCTGAGTCC
TCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTGCTCCCCTGGAGGCCTCAGA

GGAGCTACAATGAAATAAAAGCCGCATTGCAAAAAAAAAAAAAAAAAAAAAA (SEQ ID NO:120)

Translation:

5 MKLTCMVIVAVLLLTACQLITADDSRGTQKHRSLRSTTKVSKSTSCMKAGSYCRSTTRT
CCGYCAYFGKFCIDFPSN (SEQ ID NO:121)

Toxin Sequence:

10 Ser-Thr-Ser-Cys-Met-Lys-Ala-Gly-Ser-Xaa5-Cys-Arg-Ser-Thr-Thr-Arg-Thr-Cys-Cys-Gly-
Xaa5-Cys-Ala-Xaa5-Phe-Gly-Lys-Phe-Cys-Ile-Asp-Phe-Xaa3-Ser-Asn-^ (SEQ ID NO:122)

Name: Da6.8

Species: dalli

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGTTC
CTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAAGTACGCAGAAGCATCG
TGCTCTGAGGTCGACCATCAAACACTCCATGTTGACTAGGAGCTGCACGCCTCCCGG
AGGACCTTGTGGTTATTATAATGACTGCTGCAGTCATCAATGCAATATAAGCAGAA
ATAAATGCGAGTAGCTGATCCGGCATCTGATCTTCCCCTTCTGTGCTCGTCCTAACC
TGAGAGTGGTCATGAACCATCATCACCTACTCCTCTGGAGGCTTCAGAGGAGCTAC
ATGGAAATAAAAGCCGCATTGC (SEQ ID NO:123)

Translation:

MKLTCVVIVAVLFLTACQLITADDSRSTQKHRALRSTIKHSMLTRSCTPPGGPCGYND
CCSHQCNISRNKCE (SEQ ID NO:124)

Toxin Sequence:

30 Ser-Cys-Thr-Xaa3-Xaa3-Gly-Gly-Xaa3-Cys-Gly-Xaa5-Xaa5-Asn-Asp-Cys-Cys-Ser-His-Gln-
Cys-Asn-Ile-Ser-Arg-Asn-Lys-Cys-Xaa1-^ (SEQ ID NO:125)

Name: Di6.1

Species: distans

Cloned: Yes

DNA Sequence:

40 ACCAAAACCATCATCAAAATGAAACTGACGTGCGTGTTGATCATCGCCGTGCTGTTC
CTGACGGCCTGTCAACTCACTAGAGGAAAGCTGGAGCGTCCTGTTCTGAGGTCGAG
CGACCAAACCTCCGGGTCAACGAAGAGATGCGAAGATCCTGGTGAACCTTGCGGAA
GTGATCATTCCTGCTGCGGCGGTAGTTGCAACCACAACGTCTGCGCCTGAAGCTGGT
CTGGCATCTGACCATTCCCCTTCTGTACTCTATCTCTATTGCCTGAGTCATCTTTACC
45 TGTGAGTGGTCATGAATCTCTCAATACCTTCTCCCCTGGAGGCTTCAGAAGAACTAG
ATTGAAATA (SEQ ID NO:126)

Translation:

MKLTCLVLIHVLFLTLACQLTRGKLERPVLRSSDQTSKGSTKRCEDPGEPGSDHSCCGGSC
NHNVCA (SEQ ID NO:127)

5 **Toxin Sequence:**

Cys-Xaa1-Asp-Xaa3-Gly-Xaa1-Xaa3-Cys-Gly-Ser-Asp-His-Ser-Cys-Cys-Gly-Gly-Ser-Cys-
Asn-His-Asn-Val-Cys-Ala-^ (SEQ ID NO:128)

10 **Name:** E6.2
Species: ermineus
Cloned: Yes

DNA Sequence:

15 ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGTCAACTC
ATCACAGCTGACGACTCCAGACGTACGCAGAAGCATCGTGCCCTGAGGTCGACCAC
CAAACGCGCCACGTCGAATCGCCCCCTGCAAGCCGAAAGGACGAAAATGTTTTCCGC
ATCAGAAGGACTGCTGCAATAAAACGTGCACCAGATCAAAATGTCCCTGATCTTCC
20 CCCTTCTGTGCTGTATCCTTTTCTGCCTGAGTCCTCCTTACCTGAGAGTGGTCAGTAA
CCACTCATCACCATCTCCTCTGGAGG (SEQ ID NO:129)

Translation:

MKLTCLVIVAVLLLTACQLITADDSRRTQKHRALRSTTKRATSNRPCKPKGRKCFPHQK
DCCNKTCTRSKCP (SEQ ID NO:130)

25 **Toxin Sequence:**

Xaa3-Cys-Lys-Xaa3-Lys-Gly-Arg-Lys-Cys-Phe-Xaa3-His-Gln-Lys-Asp-Cys-Cys-Asn-Lys-Thr-
Cys-Thr-Arg-Ser-Lys-Cys-Xaa3-^ (SEQ ID NO:131)

30 **Name:** E6.3
Species: ermineus
Cloned: Yes

35 **DNA Sequence:**

AACTCATCACAGCTGATGACTCCAGAGGTACGCAGAACGATCGTGCCCTGAGGTCG
ACCACCAAACCTCTCCATGCTGACTCGGGCCTGCTGGTCTTCCGGAACACCTTGTGGT
ACTGATAGTTTATGCTGCGGTGGATGCAATGTATCCAAAAGTAAATGTAAGTAGCTG
ATTCGGCGTCTGAACTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCCGAGTCCTCCAT
40 ACCTGAGAATGGTCATGAACCACTCATCACCTACTCCTCTGGAGACCTCAGAAGAG
CTACACTGAAATAAAAAGCGCTTGC (SEQ ID NO:132)

Translation:

LITADDSRGTQNDRALRSTTKLSMLTRACWSSGTPCGTDSLCCGGCNVSKSKCN (SEQ
45 ID NO:133)

Toxin Sequence:

Ala-Cys-Xaa4-Ser-Ser-Gly-Thr-Xaa3-Cys-Gly-Thr-Asp-Ser-Leu-Cys-Cys-Gly-Gly-Cys-Asn-Val-Ser-Lys-Ser-Lys-Cys-Asn-^ (SEQ ID NO:134)

5 **Name:** G6.1
Species: geographus
Cloned: Yes

DNA Sequence:

10 GGATCCATGAAACTGACGTGCGTGCGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGT
 CAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGGGGTC
 GACCACCGAACTCTCCTTGTCGACTCGCTGCAAGTCACCCGGATCTTCATGTTACACC
 GACTAGTTATAATTGCTGCAGGTCTTGCAATCCATACGCCAAAAGATGTTACGGCTA
 ATCCAGCGCCTGATCTTCCCCCTTCTGTGCTCTATCCCTTCCTGTCTGAGTCCTCCTT
 15 ACCTGAGAGTGGTCATGAACCACTCCTCACCTACTTCTCTGGAGGCTTCGGAGGAGC
 TACATTGAAATAAAAAGCCGCATTGTAAAAAAAAAAAAAAAAAAAAA (SEQ ID NO:135)

Translation:

20 MKLTCVVIVAVLLLTAQLITADDSRGTQKHRALGSTTELSLSTRCKSPGSSCSPTSYNC
 CRSCNPYAKRCYG (SEQ ID NO:136)

Toxin Sequence:

25 Cys-Lys-Ser-Xaa3-Gly-Ser-Ser-Cys-Ser-Xaa3-Thr-Ser-Xaa5-Asn-Cys-Cys-Arg-Ser-Cys-Asn-
 Xaa3-Xaa5-Ala-Lys-Arg-Cys-Xaa5-# (SEQ ID NO:137)

30 **Name:** G6.2
Species: geographus
Cloned: Yes

DNA Sequence:

35 GGATCCATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGT
 CAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGAGGTC
 GTCCACCAAACCTCACCTTGTCGACTCGCTGCAAATCACCCGGAACCTCCATGTTCAAG
 GGGTATGCGTGATTGCTGCACGCCTTGCTTGTTATACAGCAACAAATGTAGGCGCTA
 CTAACCCAGCGCCTGATCTTCCCCCTTCTGTGCTCTATTCCTTTCTGCCTGAGTCCTC
 CTTACCTGAAAGTGGTCATGAACCACTCATCACCTACTTCTCTGGAGGCTTCAGAAG
 AGCTACATTGAAATAAAAAGCCGCATTGCAATGACAAAAAAAAAAAAAAAAAAAAA
 (SEQ ID NO:138)

Translation:

40 MKLTCVVIVAVLLLTAQLITADDSRGTQKHRALRSSTKLTLSTRCKSPGTPCSRGMRD
 CCTPCLLYSNKCRRY (SEQ ID NO:139)

Toxin Sequence:

45 Cys-Lys-Ser-Xaa3-Gly-Thr-Xaa3-Cys-Ser-Arg-Gly-Met-Arg-Asp-Cys-Cys-Thr-Xaa3-Cys-Leu-
 Leu-Xaa5-Ser-Asn-Lys-Cys-Arg-Arg-Xaa5-^ (SEQ ID NO:140)

Name: w-GVIA
Species: geographus
Cloned: Yes

DNA Sequence:

GGAATTCCGTTTCTGCGCTGCTTCCTTTGGCATCACCAAAACCATCATCAAAATGAA
 ACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGTCAACTCATCAC
 AGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGGGGTCGACCACCGAAC
 TCTCCTTGTCGACTCGCTGCAAGTCACCCGGATCTTCATGTTACCCGACTAGTTATA
 ATTGCTGCAGGTCTTGCAATCCATACACCAAAAGATGTTACGGCTAATCCAGCGCCT
 GATCTTCCCTGCTCTGAGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACC
 TACTTCTCTAGGCGGTTTCGGAGGAGCTACATTGAAATAAAAGCCGCATTGCAAAAAA
 AAAAAAAAAA (SEQ ID NO:141)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQKHRALGSTTELSLSTRCKSPGSSCSPTSYNC
 CRSCNPYTKRCYG (SEQ ID NO:142)

Toxin Sequence:

Cys-Lys-Ser-Xaa3-Gly-Ser-Ser-Cys-Ser-Xaa3-Thr-Ser-Xaa5-Asn-Cys-Cys-Arg-Ser-Cys-Asn-
 Xaa3-Xaa5-Thr-Lys-Arg-Cys-Xaa5-# (SEQ ID NO:143)

Name: w-GVIB
Species: geographus
Isolated: Yes

Toxin Sequence:

Cys-Lys-Ser-Xaa3-Gly-Ser-Ser-Cys-Ser-Xaa3-Thr-Ser-Xaa5-Asn-Cys-Cys-Arg-Ser-Cys-Asn-
 Xaa3-Xaa5-Thr-Lys-Arg-Cys-Xaa5-Gly-# (SEQ ID NO:144)

Name: w-GVIC
Species: geographus
Isolated: Yes

Toxin Sequence:

Cys-Lys-Ser-Xaa3-Gly-Ser-Ser-Cys-Ser-Xaa3-Thr-Ser-Xaa5-Asn-Cys-Cys-Arg-Ser-Cys-Asn-
 Xaa3-Xaa5-Thr-Lys-Arg-Cys-# (SEQ ID NO:145)

Name: w-GVIA
Species: geographus
Isolated: Yes
Cloned: Yes

DNA Sequence:

CATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGAGGTCGTCCA
 CCAAACCTCACCTTGTCGACTCGCTGCAAATCACCCGGAACCTCCATGTTCAAGGGGTA
 5 TGC GTGATTGCTGCACGTCTTGCTTGTTATACAGCAACAAATGTAGGCGCTACTAAC
 CCAGCGCCTGATCTTCCCCCTTCTGTGCTCTATTCTTTCTGCCTGAGTCCTCCTTAC
 CTGAAAGTGGTCATGAACCACTCATCACCTACTTCTCTGGAGGCTTCAGAAGAGCTA
 CATTGAAATAAAAGCCGCATTGCAATGAC (SEQ ID NO:146)

Translation:

ITADDSRGTQKHRALRSSTKLTLSTRCKSPGTPCSRGMRDCTSCLLYSNKCRRY (SEQ
 ID NO:147)

Toxin Sequence:

Cys-Lys-Ser-Xaa3-Gly-Thr-Xaa3-Cys-Ser-Arg-Gly-Met-Arg-Asp-Cys-Cys-Thr-Ser-Cys-Leu-
 Leu-Xaa5-Ser-Asn-Lys-Cys-Arg-Arg-Xaa5-# (SEQ ID NO:148)

Name: w-GVIIB

Species: geographus

Isolated: Yes

Toxin Sequence:

Cys-Lys-Ser-Xaa3-Gly-Thr-Xaa3-Cys-Ser-Arg-Gly-Met-Arg-Asp-Cys-Cys-Thr-Ser-Cys-Leu-
 Ser-Xaa5-Ser-Asn-Lys-Cys-Arg-Arg-Xaa5-# (SEQ ID NO:149)

Name: La6.1

Species: laterculatus

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAACTCATCACCGCTGATGACTCCAGAGGTACGCAGAAGCATC
 35 GTGCCCTGAGGTCGACCACCAATCTCTCCATGCTGACTCGGAAGTGCTGGCCTTCCG
 GAAGCTATTGTCGTGCGAATAGTAAATGCTGCAGTGGATGCGATCGGAACAGAAAT
 AAATGTTACTAGCTGATTTCGGCGTCTGAACTTCCTCCTTCTGTGCTCTATCCTTTTCT
 GCCCGAGTCCTCCATACCTGAGAGTGGTCATGAACCACTCAACTCCTACTCCTCTGG
 AGGCCTCAGAAGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:150)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQKHRALRSTTNLSMLTRKCWPSGSYCRANS
 KCCSGCDNRNRNKCY (SEQ ID NO:151)

Toxin Sequence:

Lys-Cys-Xaa4-Xaa3-Ser-Gly-Ser-Xaa5-Cys-Arg-Ala-Asn-Ser-Lys-Cys-Cys-Ser-Gly-Cys-Asp-
 Arg-Asn-Arg-Asn-Lys-Cys-Xaa5-^ (SEQ ID NO:152)

Name: La6.2
Species: laterculatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTGCCCTGAGGTGCGACCACCAAACCTCTCCATATCGACTCGCTGCCTTCCTCCCGGAT
 CATATTGTAAGGCGACAACGGAAGTCTGCTGCTCTTCTTGCCTTCAATTCGCTCAGA
 TATGTTCCGGTTGATCTTCCCTCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCAT
 ACCTGAGAATGGTCATGAACCACTCAACATCTACTCCTCTGGAGGCCTCAGAAGAG
 CTATATTGAAATAAAAGCCGCATTGC (SEQ ID NO:153)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQKHRALRSTTKLSISTRCLPPGSYCKATTEVC
 CSSCLQFAQICSG (SEQ ID NO:154)

Toxin Sequence:

Cys-Leu-Xaa3-Xaa3-Gly-Ser-Xaa5-Cys-Lys-Ala-Thr-Thr-Xaa1-Val-Cys-Cys-Ser-Ser-Cys-Leu-
 Gln-Phe-Ala-Gln-Ile-Cys-Ser-# (SEQ ID NO:155)

Name: La6.3
Species: laterculatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTGCCCTGAGGTGCGACCACCAATCTCTCCATGTGCGACTCGCTGCAAGTCTCCCGGAT
 CATCATGTAGCGTGTCTATGCGTAACTGCTGCACTTCTTGCAATTCACGCACCAAGA
 AATGTACGCGACGTGGCTGAACTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCCCGAGT
 CCTCCATACCTGAGAGTGGTCATGAACCACTCAACATCTACTCCTCTGGAGGCCTCA
 GAAGAGCTATATTGAAATAAAAGCCGCATTGC (SEQ ID NO:156)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQKHRALRSTTNLSMSTRCKSPGSSCSVSMRN
 CCTSCNSRTKKCTRRG (SEQ ID NO:157)

Toxin Sequence:

Cys-Lys-Ser-Xaa3-Gly-Ser-Ser-Cys-Ser-Val-Ser-Met-Arg-Asn-Cys-Cys-Thr-Ser-Cys-Asn-Ser-
 Arg-Thr-Lys-Lys-Cys-Thr-Arg-Arg-# (SEQ ID NO:158)

Name: La6.4
Species: laterculatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTGCCCTGAGGTGCGACAACCAAACCTCTCCATGCTGACTCGGACCTGCTGGCCTTCCG
 GAACAGCTTGTGGTATTGATAGTAACTGCTGCAGTGGATGCAATGTATCCAGAAGT
 AAATGTAAGTCTGATTTCGGCGTCTAAACTTCCTCCTTCTGCCTGAGTCCTCCATA
 CCTGAGAGTGGTCATGAACCACATCATCACCTCATCTCTGGAGGCCTC (SEQ ID
 NO:159)

Translation:

MKLTCVVIVAVLLLACQLITADDSRGTQKHRALRSTTKLSMLTRTCWPSGTACGIDSN
 CCSGCNVSRSKCN (SEQ ID NO:160)

Toxin Sequence:

Thr-Cys-Xaa4-Xaa3-Ser-Gly-Thr-Ala-Cys-Gly-Ile-Asp-Ser-Asn-Cys-Cys-Ser-Gly-Cys-Asn-
 Val-Ser-Arg-Ser-Lys-Cys-Asn-^ (SEQ ID NO:161)

Name: La6.5
Species: laterculatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTGCCCTGAGGTGCGACCACCAATCTCTCCATGCTGACTCGGAAGTGCTGGCCTTCCG
 GAAGCTATTGTCGTGCGAATAGTAAATGCTGCAGTGGATGCGATCGGAACAGAAGT
 AAATGTAAGTCTGATTTCGGCGTCTAAACTTCCTCCTTCTGCCTGAGTCCTCCATA
 CCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGGAGGCCTCAAAGGAGCT
 ACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:162)

Translation:

MKLTCVVIVAVLLLACQLITADDSRGTQKHRALRSTTNLSMLTRKCWPSGSYCRANS
 KCCSGCDNRNRKCN (SEQ ID NO:163)

Toxin Sequence:

Lys-Cys-Xaa4-Xaa3-Ser-Gly-Ser-Xaa5-Cys-Arg-Ala-Asn-Ser-Lys-Cys-Cys-Ser-Gly-Cys-Asp-
 Arg-Asn-Arg-Ser-Lys-Cys-Asn-^ (SEQ ID NO:164)

Name: Lp6.1
Species: leopardus
Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTAGCTGTGCTGTTCCCTGACGGCCTGTCAACTC
 ACTACAGCTGACATCTCCAGAGGTACGCGGAAGCGTCGTGCTCTGAGGTCGACCAC
 5 CAAACTCTCCAGGTCGCTCTTTGAGTGCGCGCCTTCCGGTGGACGTTGTGGTTTTTTA
 AAGTCCTGCTGCGAAGGATATTGCGATGGGGAAAGCACTTCATGTGTGAGTGGCCC
 ATACAGCATCTGATCTTCCCGCCTTCAGTGCTCTATCCTTTTCTGCCTGAGTCCTCCA
 TACCTCTGAGCGGTCATGAACCACTCAACACCTACTCCTCTGGAGGCTTCAGGGAAC
 TATATTAAAATAAAGCCGCATTGCAACGAAANAAAAAAAAAAAAAAAAAAAA (SEQ ID
 10 NO:165)

Translation:

MKLTCVVIVAVLFLTACQLTTADISRGTRKRRLRSTTKLSRSLFECAPSGGRCGFLKSC
 CEGYCDGESTSCVSGPYSI (SEQ ID NO:166)

Toxin Sequence:

Ser-Leu-Phe-Xaa1-Cys-Ala-Xaa3-Ser-Gly-Gly-Arg-Cys-Gly-Phe-Leu-Lys-Ser-Cys-Cys-Xaa1-
 Gly-Xaa5-Cys-Asp-Gly-Xaa1-Ser-Thr-Ser-Cys-Val-Ser-Gly-Xaa3-Xaa5-Ser-Ile-^ (SEQ ID
 NO:167)

Name: Lp6.2
Species: leopardus
Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCTGTGCTGTTCCCTGACGGCCTGTCAACTC
 ACTACAGCTGACATCTCCAGAGGTACGTGGAAGCATCGTGGTGTGGGGTTCGACCAC
 CGGACTCTCCCCGTGGCCCTTGGACTGCACGGCTCCCAGTCAACCTTGTGGTTATTT
 30 TCCTAGGTGCTGTGGACATTGCGATGTACGCAGGGTATGTACGAGTGGCTGATCCG
 GCGTCTGATCTTTCCGCCTTCTGTGCTGTATCCTTTTCTGCCTGAGTCCTCCATACCC
 GTGAGTGGTCATGAACCACTCAACACCTACTCCTCTGGAGGCTTCAGAGGAACTAT
 ATTAAAATAAAGCCGCATTGCAATG (SEQ ID NO:168)

Translation:

MKLTCVVIVAVLFLTACQLTTADISRGTWKHRGVGSTTGLSPWPLDCTAPSQPCGYFPR
 CCGHCDVRRVCTSG (SEQ ID NO:169)

Toxin Sequence:

Xaa4-Xaa3-Leu-Asp-Cys-Thr-Ala-Xaa3-Ser-Gln-Xaa3-Cys-Gly-Xaa5-Phe-Xaa3-Arg-Cys-Cys-
 Gly-His-Cys-Asp-Val-Arg-Arg-Val-Cys-Thr-Ser-# (SEQ ID NO:170)

Name: Lp6.3
Species: leopardus
Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCTGTGCTGTTCCCTGACGGCCTGTCAACTC
 ACTACAGCTGACATCTCCAGAGGTACGCGGAAGCATCGTGCTCTGAGGTGCGACCAC
 CAAACTCTCCAGGTGCGCCCTCTAGGTGCATGTCTCCCGGTGGAATTTGTGGTGATT
 5 TGGTGACTGCTGCGAAATTTGCAATGTGTACGGTATATGTGTGAGTGACTTACCCGG
 CATCTGATCTTTCCGCCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCCTCCATACCCCT
 GAGTGGTCATGGACCACTCAACACCTACTCCTCTGGAGGCTTCAGAGGAACTACATT
 AAAATAAAGCCGCATTGCAAAAAAAAAAAAAAAAAAAAAA (SEQ ID NO:171)

Translation:

MKLTCVVIVAVLFLTACQLTTADISRGTRKHRALRSTTKLSRSPSRCMSPGGICGDFGDC
 CEICNVYGICVSDLPGI (SEQ ID NO:172)

Toxin Sequence:

15 Cys-Met-Ser-Xaa3-Gly-Gly-Ile-Cys-Gly-Asp-Phe-Gly-Asp-Cys-Cys-Xaa1-Ile-Cys-Asn-Val-
 Xaa5-Gly-Ile-Cys-Val-Ser-Asp-Leu-Xaa3-Gly-Ile-^ (SEQ ID NO:173)

Name: Lp6.4

Species: leopardus

Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCTGTGCTGTTCCCTGACGGCCTGTCAACTC
 ACTACAGCTGATGATTCCAGAGGTACACGGAAGCATCGTGCTCTGAGGTCAACCAC
 CAAACTCTCCAGGTGGCCCAGGTACTGCGCGCCTCCCGGTGGAGCTTGTGGGTTTTT
 TGATCACTGCTGCGGATATTGCGAAACGTTTTACAATACGTGTAGATGAGTTGGCTG
 ATCCGGCGCTTGATCTTTCCGCCTTCTGTTGCTCTATCTTTTCTGCCTGAGTCCTCCC
 ATACCCCGTTGAGTGGTCCATGAACCACTCCAACACCTACTCCCTCCTTGGAAGCTT
 30 CCAAAGGAAACGACATTTAAATAAATTCCCCATTGCAATTGGAAAAAAAAAAAAAAAA
 AAAAA (SEQ ID NO:174)

Translation:

MKLTCVVIVAVLFLTACQLTTADDSRGTRKHRALRSTTKLSRWPRYCAPPGGACGFFD
 35 HCCGYCETFYNTCR (SEQ ID NO:175)

Toxin Sequence:

Xaa5-Cys-Ala-Xaa3-Xaa3-Gly-Gly-Ala-Cys-Gly-Phe-Phe-Asp-His-Cys-Cys-Gly-Xaa5-Cys-
 Xaa1-Thr-Phe-Xaa5-Asn-Thr-Cys-Arg-^ (SEQ ID NO:176)

Name: L6.1

Species: lynceus

Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGTCAACTC

ATCACAGCTGATGACTCCAGACGTACACAGAAGCATCGTGCCCTGAGGTGCGACCAC
 CAATCTCTCCATGTCGACTCGCTGCAAGTCTCCCGGATCACCATGTAGTGTGACATC
 GTATAACTGCTGCACTTTTTGCTCTTCATACACTAAGAAATGTCGGGCCTCTTTATGA
 ACCACTCATCACCTACTCCTCTGGAGGCCTCAGAAGAGCTACACTGAAATAAAAGC
 CGCATTGG (SEQ ID NO:177)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRRTQKHRALRSTTNLSMSTRCKSPGSPCSVTSYN
 CCTFCSSYTKKCRASL (SEQ ID NO:178)

Toxin Sequence:

Cys-Lys-Ser-Xaa3-Gly-Ser-Xaa3-Cys-Ser-Val-Thr-Ser-Xaa5-Asn-Cys-Cys-Thr-Phe-Cys-Ser-
 Ser-Xaa5-Thr-Lys-Lys-Cys-Arg-Ala-Ser-Leu-^ (SEQ ID NO:179)

Name: L6.2
Species: lynceus
Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTCCTGACGGCCTGTCAACTC
 ATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGAGGTGCGACCAC
 CAAACTATCCATGTATACTCGCTGCGCAGGTCCAGGAGCAATTTGTCCTAATAGGGT
 ATGCTGCGGTTATTGCAGTAAAAGAACACATCTATGTCATTCGCGAACTGGCTGATC
 TTCCCCCTTCTGTGCTCTATCCTTTTTCTGCCTGAGTCCTCCATACCTGAGAATGGTC
 ATGAACCACTCATCACCTACTCCTCTTGGAGACCTCAGAGGAGCTACACTGAAATA
 AAAGCCGCATTGGC (SEQ ID NO:180)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQKHRALRSTTKLSMYTRCAGPGAICPNRVCC
 GYCSKRTHLCHSRTG (SEQ ID NO:181)

Toxin Sequence:

Cys-Ala-Gly-Xaa3-Gly-Ala-Ile-Cys-Xaa3-Asn-Arg-Val-Cys-Cys-Gly-Xaa5-Cys-Ser-Lys-Arg-
 Thr-His-Leu-Cys-His-Ser-Arg-Thr-# (SEQ ID NO:182)

Name: L6.3
Species: lynceus
Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCTGCTAGCGGCCTGTCAACTA
 CTACACGCTGATGACTCCAGAGGTACGCAGAAGACTGCTGCCCCGAGGTGCGACCACC
 AAAACTCTCCATGCTGACTCGGGCCTGCTGGTCTTCCGGAACACCTTGTGGTACTGA
 TAGTTTATGCTGCGGTGGATGCAATGTATCCAAAAGTAAATGTAAGTACTGATTCG
 GCGTCTGAACTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCCGAGTCCTCCATACCTG

AGAATGGTCATGAACCACTCATCACCTACTCCTCTGGAGACCTCAGAAGAGCTACA
CTGAAATAAAAGCGCATTGC (SEQ ID NO:183)

Translation:

MKLTCVVIVAVLLLAACQLLHADDSRGTQKTAARGRPPKLSMLTRACWSSGTPCGTDS
LCCGGCNVSKSKCN (SEQ ID NO:184)

Toxin Sequence:

Ala-Cys-Xaa4-Ser-Ser-Gly-Thr-Xaa3-Cys-Gly-Thr-Asp-Ser-Leu-Cys-Cys-Gly-Gly-Cys-Asn-
Val-Ser-Lys-Ser-Lys-Cys-Asn-^ (SEQ ID NO:185)

Name: L6.4

Species: lynceus

Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCCGAGCTACTCCTAACGGCCTGTCAACTC
ATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCGTGCCCTGAGGTCGACCAC
CAATCTCTCCATGCTGACTCGGAAGTGCTGGTCTCCCGGAACCTATTGTCGTGCGCA
TAGTAAATGCTGCCGTGGATGCGATCAGAACAGAAATAAATGTTACTAGCTGATTC
GGCGTCTGAACTTCCTCCTTCTGTGCTCTATCCTTTTTCTGCCTGAGTCCTCCATACC
TGAGAATGGTCATGAACCACTCATCACCTACTCCTCTGGAGGCCTCAGAGGAGCCT
ACACTGAAATAAAAGCCGCATTGG (SEQ ID NO:186)

Translation:

MKLTCVVIVAEALLTACQLITADDSRGTQKHRALRSTTNLSMLTRKCWSPGTYCRAHS
KCCRGCDQNRNKCY (SEQ ID NO:187)

Toxin Sequence:

Lys-Cys-Xaa4-Ser-Xaa3-Gly-Thr-Xaa5-Cys-Arg-Ala-His-Ser-Lys-Cys-Cys-Arg-Gly-Cys-Asp-
Gln-Asn-Arg-Asn-Lys-Cys-Xaa5-^ (SEQ ID NO:188)

Name: M6.1

Species: magus

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
GTGCCCTGAGGTCGGACACCAAACTCTCCATGTCGACTCGCTGCAAGGGTACAGGA
AAACCATGCAGTAGGATTGCGTATAACTGCTGCACCGGTTCTTGCAGATCAGGTAA
ATGTGGCTGATCCAGTGCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTTCTGCCTG
AGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCA (SEQ ID NO:189)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQKHRALRSDTKLSMSTRCKGTGKPCSRIAYN
CCTGSCRSKGKCG (SEQ ID NO:190)

Toxin Sequence:

5 Cys-Lys-Gly-Thr-Gly-Lys-Xaa3-Cys-Ser-Arg-Ile-Ala-Xaa5-Asn-Cys-Cys-Thr-Gly-Ser-Cys-Arg-Ser-Gly-Lys-Cys-# (SEQ ID NO:191)

Name: M6.2

10 **Species:** magus

Cloned: Yes

DNA Sequence:

15 ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
GTGCCCTGAAGTCGGACACCAAACTCTCCATGTAACTTTGCGCTGCGCATCTTACG
GAAAACCTTGTGGTATTTACAACGACTGCTGCAATACATGCGATCCAGCCAGAAAG
ACATGTACGTAGCTGATCCGGCGTCTGATCTTCC (SEQ ID NO:192)

Translation:

20 MKLTCVVIVAVLLLTACQLITADDSRGTQKHRALKSDTKLSMLTLRCASYGKPCGIYN
DCCNTCDPARKTCT (SEQ ID NO:193)

Toxin Sequence:

25 Cys-Ala-Ser-Xaa5-Gly-Lys-Xaa3-Cys-Gly-Ile-Xaa5-Asn-Asp-Cys-Cys-Asn-Thr-Cys-Asp-Xaa3-Ala-Arg-Lys-Thr-Cys-Thr-^ (SEQ ID NO:194)

Name: w-MVIIB

30 **Species:** magus

Isolated: Yes

Cloned: Yes

DNA Sequence:

35 GAATTTTCAGCATCACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATC
GTCGCCGTGCTGCTCCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGT
ACGCAGAAGCATCGTGCCCTGAGGTCGGACACCAAACTCTCCATGTCAACTCGCTG
CAAGGGTAAAGGAGCATCATGTCATAGGACTTCGTATGACTGCTGCACCGGTTCTTG
CAACAGAGGTAAATTTGGCTGATCCGCC (SEQ ID NO:195)

Translation:

40 MKLTCVVIVAVLLLTACQLITADDSRGTQKHRALRSDTKLSMSTRCKGKGASCHRTSY
DCCTGSCNRGKFG (SEQ ID NO:196)

Toxin Sequence:

45 Cys-Lys-Gly-Lys-Gly-Ala-Ser-Cys-His-Arg-Thr-Ser-Xaa5-Asp-Cys-Cys-Thr-Gly-Ser-Cys-Asn-Arg-Gly-Lys-Cys-# (SEQ ID NO:197)

Name: Mi6.1

Species: miles

5 **Cloned:** Yes

DNA Sequence:

10 GGATCCATGAAACTGACGTGCGTGGTGATCATCGCCATGCTGTTTCCTGACAGCCTAT
CAACTCGCTACAGCTGCGAGCTACGCCAAAGGTAAACAGAAGCATCGTGCTCTGAG
GCCAGCTGACAAACACCTCAGGTTGACCAAGCGTTGCAATGATCGCGGTGGAGGTT
GCAGTCAACATCCTCACTGCTGCGGTGGAACCTGCAATAAGCTTATTGGCGTATGTC
TGTAAGCTGGTCTGCCGTCTGATATTCCCTTTCTGTGCTTCATCCTCTTTTGCCTGA
GTCATCCATACCTGTGAATGGTTAAGAGCCACTCAATACCTATTCTCTGGGGGCTT
CAGAGGAACTACTTTAC (SEQ ID NO:198)

Translation:

MKLTCVVIIAMLFLTAYQLATAASYAKGKQKHRALRPADKHLRLTKRCNDRGGGCSQ
HPHCCGGTCNKLIGVCL (SEQ ID NO:199)

Toxin Sequence:

Cys-Asn-Asp-Arg-Gly-Gly-Gly-Cys-Ser-Gln-His-Xaa3-His-Cys-Cys-Gly-Gly-Thr-Cys-Asn-
Lys-Leu-Ile-Gly-Val-Cys-Leu-^ (SEQ ID NO:200)

25 **Name:** Mn6.1

Species: monachus

Cloned: Yes

DNA Sequence:

30 ACCAAAACCATCATCAAAATGAAACTGACGAGTGTGGTGATCGTCGCCGTGCTGCT
CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
GTGCCCTGAGGTTCGGACACCAAACCTCTCCATATCGACTCGCTGCAAGTCTACAGGA
AAATCATGCAGTAGGATTGCGTATAACTGCTGCACCGGTTCTTGAGATCAGGTAA
ATGTGGCTGATCCAGCGCCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGA
35 GTCCTCCTTA (SEQ ID NO:201)

Translation:

MKLTSVVIVAVLLLLTACQLITADDSRGTQKHRALRSDTKLSISTRCKSTGKSCSRIAYNC
CTGSCRSGKCG (SEQ ID NO:202)

Toxin Sequence:

Cys-Lys-Ser-Thr-Gly-Lys-Ser-Cys-Ser-Arg-Ile-Ala-Xaa5-Asn-Cys-Cys-Thr-Gly-Ser-Cys-Arg-
Ser-Gly-Lys-Cys-# (SEQ ID NO:203)

45 **Name:** Mn6.2

Species: monachus

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGAGTGTGGTGATCGTCGCCGTGCTGCT
 5 CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTGCCCTGAGGTTCGGACACCAACCTCTCCATGTCGACTCGCTGCAAGGGTAAAGGA
 TCTTCATGTAGTAGGACCATGTATAACTGCTGCACCGGTTCTTGCAACAGAGGTAAA
 TGTGGCTGATCCAGCGCCTGATCTTCCCCCTTC (SEQ ID NO:204)

Translation:

MKLTSVVIVAVLLLACQLITADDSRGTQKHRALRSDTNLSMSTRCKGKGSSCSRTMY
 NCCTGSCNRGKCG (SEQ ID NO:205)

Toxin Sequence:

15 Cys-Lys-Gly-Lys-Gly-Ser-Ser-Cys-Ser-Arg-Thr-Met-Xaa5-Asn-Cys-Cys-Thr-Gly-Ser-Cys-
 Asn-Arg-Gly-Lys-Cys-# (SEQ ID NO:206)

Name: O6.1

Species: obscurus

Cloned: Yes

DNA Sequence:

ctctctctctctctgctggacAGGTTCGCCTCCCTGCATGAAAGGCGGATCGTCATGCCGCGGTAC
 25 TACGGGAGTCTGTTGCGGTTTTTGCAGTGATTTTCGGCTATAAATGTAGGGACTATCC
 CCAAACTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGTCCGAGTCCTCCTGACC
 TGAGAGTGGTCATGAACCACTCATCACCTACCCCTCTGGGGCTTCACAGGATCTACA
 TTGAAATAAAAGCCGCATTGC (SEQ ID NO:207)

Translation:

LLDRSPPCMKGSSCRGTTGVCCGFCSDFGYKCRDYPQN (SEQ ID NO:208)

Toxin Sequence:

35 Ser-Xaa3-Xaa3-Cys-Met-Lys-Gly-Gly-Ser-Ser-Cys-Arg-Gly-Thr-Thr-Gly-Val-Cys-Cys-Gly-
 Phe-Cys-Ser-Asp-Phe-Gly-Xaa5-Lys-Cys-Arg-Asp-Xaa5-Xaa3-Gln-Asn-^ (SEQ ID NO:209)

Name: O6.2

Species: obscurus

Cloned: Yes

DNA Sequence:

ctctctctctctctgctggacAGGTTCGACTCGCTGCTTGCCTGACGGAACGTCTTGCCTTTTTAGT
 45 AGGATCAGATGCTGCGGTACTTGCAGTTCAATCTTAAAGTCATGTGTGAGCTGATCC
 AGCGGTTGATCTTCCCTCCCTCTGTGCTCCATCCTTTTCTGCCTGAGTTCTCCTTACCT
 GAGAGTGGTCATGAACCACTCATCACCTACTCTTCTGGAGGCTTCAGAGGAGCTAC
 ATTGAAATAAAAGCCGCATTGC (SEQ ID NO:210)

Translation:

RSTRCLPDGTSCLFSRIRCCGTCSSILKSCVS (SEQ ID NO:211)

5 **Toxin Sequence:**

Cys-Leu-Xaa3-Asp-Gly-Thr-Ser-Cys-Leu-Phe-Ser-Arg-Ile-Arg-Cys-Cys-Gly-Thr-Cys-Ser-Ser-Ile-Leu-Lys-Ser-Cys-Val-Ser-^ (SEQ ID NO:212)

10 **Name:** Pu6.2
Species: pulicarius
Cloned: Yes

DNA Sequence:

15 ATGAAACTGACGTGTGTGGTGATCATCGCCGTGCTGTTCCCTGACGGCCTGTCAACTC
ATTACAGCTGAGACTTACTCCAGAGGTAAGCAGAAGCACCGTGCTTTGAGGTCAAC
TGACAAAAACTCCAAGTTGACTAGGCAGTGCTCGCCTAACGGTGGATCTTGTTCTCG
TCATTTTCACTGCTGCAGCCTCTATTGCAATAAAAATACTGGCGTATGTATTGCAAC
CTAATAACCCGTGTGTGGTCATGAACCACTCAATACCCTCTCCTCTGGAGGCTTCAGA
20 GGAAGTGCATTGAAATAAAACTGCATTGCNTTGACCAAAAAAAAAA (SEQ ID
NO:213)

Translation:

25 MKLTCVVIIAVLFLTACQLITAETYSRGKQKHRALRSTDKN SKLTRQCSPNGGSCSRHF
HCCSLYCNKNTGVCIAT (SEQ ID NO:214)

Toxin Sequence:

30 Xaa2-Cys-Ser-Xaa3-Asn-Gly-Gly-Ser-Cys-Ser-Arg-His-Phe-His-Cys-Cys-Ser-Leu-Xaa5-Cys-
Asn-Lys-Asn-Thr-Gly-Val-Cys-Ile-Ala-Thr-^ (SEQ ID NO:215)

35 **Name:** P6.1
Species: purpurascens
Cloned: Yes

DNA Sequence:

40 ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGTTCCCTGACGGCCTGTCAACTC
ATCACAGCTGATGACTCCAGACGTACGCAGAAGCATCGTGCCCTGAGGTCGACCAC
CAAAGGCGCCACGTCGAATCGCCCCTGCAAGACACCCGGACGAAAATGTTTTCCGC
ATCAGAAGGACTGCTGCGGTGAGCGTGCATCATCACAATATGTCCCTGATCTTCCC
CCTTCTGTGCTGTATCCTTTTCTGCCTGAGTCTCCTTACCTGAGAGTGGTCATGAA
(SEQ ID NO:216)

Translation:

45 MKLTCVVIVAVLFLTACQLITADDSRRTQKHRALRSTTKGATSNRPCKTPGRKCFPHQK
DCCGRACIITICP (SEQ ID NO:217)

Toxin Sequence:

Xaa3-Cys-Lys-Thr-Xaa3-Gly-Arg-Lys-Cys-Phe-Xaa3-His-Gln-Lys-Asp-Cys-Cys-Gly-Arg-Ala-Cys-Ile-Ile-Thr-Ile-Cys-Xaa3-^ (SEQ ID NO:218)

Name: P6.2
Species: purpurascens
Isolated: Yes
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTGCCCTGAGGTGACCAACCAAACTCTTCACGTGCGAAAAGCTGCAAGCTTCCCGGA
 GCATATTGTAATGCAGAAGATTATGACTGCTGCCTTAGATGCAAAGTTGGAGGTAC
 ATGTGGCTGATCCAGTGCCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGA
 GTCCTCCTTACCTAAGAGTGGTCATGAACCACTCATCACCTTCTCCTCTGGAGGCTT
 C (SEQ ID NO:219)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQKHRALRSTTKLFTSKSCKLPGAYCNAEDYD
 CCLRCKVGGTCG (SEQ ID NO:220)

Toxin Sequence:

Ser-Cys-Lys-Leu-Xaa3-Gly-Ala-Xaa5-Cys-Asn-Ala-Xaa1-Asp-Xaa5-Asp-Cys-Cys-Leu-Arg-
 Cys-Lys-Val-Gly-Gly-Thr-Cys-# (SEQ ID NO:221)

Name: P6.3
Species: purpurascens
Cloned: Yes

DNA Sequence:

ATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGTTCTTGACGGCCTGTCAACTC
 ATCACAGCTGATGACTCCAGACGTACGCAGAAGCATCGTGCCCTGAGGTGACCAAC
 CAAACGCGCCACGTGCAATCGCCCCTGCAAGAAAACCGGACGAAAATGTTTTCCGC
 ATCAGAAGGACTGCTGCGGTGAGCGTGCATCATCACAATATGTCCCTGATCTTCCC
 CCTTCTGTGCTGTATCCTTTTCTGCCTGAGTCCTCCTTACCTGAGAGTGGTCATGAAC
 CACTCATCACCTTCTCCTCTGGAGGCTTCAGAG (SEQ ID NO:222)

Translation:

MKLTCVVIVAVLFLTACQLITADDSRRTQKHRALRSTTKRATSNRPCKKTGRKCFPHQK
 DCCGRACIITICP (SEQ ID NO:223)

Toxin Sequence:

Xaa3-Cys-Lys-Lys-Thr-Gly-Arg-Lys-Cys-Phe-Xaa3-His-Gln-Lys-Asp-Cys-Cys-Gly-Arg-Ala-
 Cys-Ile-Ile-Thr-Ile-Cys-Xaa3-^ (SEQ ID NO:224)

Name: R6.1
Species: radiatus
Cloned: Yes

DNA Sequence:

GCTGATGCCTGATCTTCATCGTTCTTCCCTGTCTCCTTTGGCATCACCAAAACCATCA
TCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGGTCCTGACGGCCTGTC
AACTCATCACAGCTGATGACTCCAGAGGTATGCAGAAACATCATGCCCTGGGGTCG
ATCAGCAGTCTCTTTAAGTCGACCCGTCATGGCTGCAAACCCCTCAAACGTCGTTGT
TTCAATGATAAAGAATGCTGCAGCAAATTTTGCAATTCAGTCCGAAAGCAGTGTGG
ATAAATGGCTAAAAAACTGAATAAAAGCCGCATTGCAAAAAAAA (SEQ ID NO:225)

Translation:

MKLTCVVIVAVLVLTACQLITADDSRGMQKHHLGSISSLFKSTRHGCKPLKRRCFNDK
ECCSKFCNSVRKQCG (SEQ ID NO:226)

Toxin Sequence:

His-Gly-Cys-Lys-Xaa3-Leu-Lys-Arg-Arg-Cys-Phe-Asn-Asp-Lys-Xaa1-Cys-Cys-Ser-Lys-Phe-
Cys-Asn-Ser-Val-Arg-Lys-Gln-Cys-# (SEQ ID NO:227)

Name: R6.2
Species: radiatus
Cloned: Yes

DNA Sequence:

GAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGGTCCTGACGGCCTGTCA
ACTCATCACAGCTGATGACTCCAGAGGTATGCAGAAACATCATGCCCTGGGGTCGA
TCAGCAGTCTCTTTAAGTCGACCCGTCGTGGCTGCAAACCCCTCAAACGTCGTTGTT
TCAATGATAAAGAATGCTGCAGCAAATTTTGCAATTCAGTCCGAAACCAGTGTGGA
TAAATGGCTAAAAAACTGAATAAAAG (SEQ ID NO:228)

Translation:

MKLTCVVIVAVLVLTACQLITADDSRGMQKHHLGSISSLFKSTRRGCKPLKRRCFNDK
ECCSKFCNSVRNQCG (SEQ ID NO:229)

Toxin Sequence:

Arg-Gly-Cys-Lys-Xaa3-Leu-Lys-Arg-Arg-Cys-Phe-Asn-Asp-Lys-Xaa1-Cys-Cys-Ser-Lys-Phe-
Cys-Asn-Ser-Val-Arg-Asn-Gln-Cys-# (SEQ ID NO:230)

Name: w-RVIA
Species: radiatus
Cloned: Yes

DNA Sequence:

GGAATTCCGCTTGCACGGCGAACCTGACTTCATCTTTCTTCCCTGCCTCCTTTGGCAT
 CACCAAAACCATCATCAAAATGAACTGACGTGTGTGGTGATCGTCGCCGTGCTGG
 TCCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTATGCAGAAGCAT
 5 CATGCCCTGAGGTCGATCACCAAACCTCTCCCTGTCGACTCGCTGCAAACCTCCCGGA
 TCACCATGTAGAGTTTCTTCGTATAACTGCTGCTCTTCTTGCAAATCATAACAAG
 AAATGTGGCTGAACTTCCCCTTCTGTGCTCTATCCTTTTCTGCCCCGAGTCCTCCATA
 CCTGAGAGTAGTCATGAACCACTGATTACCTACTCCTCTGGAGGGCCTCAGAGGAG
 CTACTTTGAAATAAAAGCCCGCATTGCAAAAAAAAAA (SEQ ID NO:231)

Translation:

MKLTCVVIVAVLVLTAQLITADDSRGMQKHHLRSITKLSLSTRCKPPGSPCRVSSYN
 CCSSCKSYNKKCG (SEQ ID NO:232)

Toxin Sequence:

Cys-Lys-Xaa3-Xaa3-Gly-Ser-Xaa3-Cys-Arg-Val-Ser-Ser-Xaa5-Asn-Cys-Cys-Ser-Ser-Cys-Lys-
 Ser-Xaa5-Asn-Lys-Lys-Cys-Gly-# (SEQ ID NO:233)

Name: Ra6.1

Species: rattus

Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGCATGGTGATCATCGCCGTGCTGTTCTGACAGCCTGT
 CAATTCGATACAGCTGCGAGCTACGACAAAGGTAAGCAGAAACCTCCTACTCTGAG
 GCCAGCTGACAAACACATCAGGTTGACCAAGCGTTGCAATGCTCGCAATGATGGTT
 GCAGTCAACATTCTCAATGCTGCAGTGGATCTTGCAATAAGACTGCAGGCGTATGTC
 TGTAAGCTGGTCTGCCGTCTGATATTCCTTTCTGTGCTTTATCCTCTTTTGCCTGA
 25 GTCATCCATACCTGTGAATGGTTAAGAGCCACTCAATACCTACTCCTCTGGGGGCTT
 CAGAGGAACTACATTAAATAAAGCCACATTGCAAAAAAAAAAAAAAAAAAAAAA (SEQ
 ID NO:234)

Translation:

MKLTCMVIIAVLFLTACQFDTAASYDKGKQKPPTLRPADKHRLTKRCNARNDGCSQH
 SQCCSGSCNKTAGVCL (SEQ ID NO:235)

Toxin Sequence:

Cys-Asn-Ala-Arg-Asn-Asp-Gly-Cys-Ser-Gln-His-Ser-Gln-Cys-Cys-Ser-Gly-Ser-Cys-Asn-Lys-
 40 Thr-Ala-Gly-Val-Cys-Leu-^ (SEQ ID NO:236)

Name: Ra6.2

Species: rattus

Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGCGTGGTGATCATCGCCGTGCTGTTTCCTGACAGCCTGT
CAACTCGATGCAGCTGCGAGCTACGACAAAGGTAAGCAGAAACCTCCTACTCTGAG
GCCAGCTGACAAACACTTCAGGTTGATCAAGCGTTGCAATGCTCGCAATAGTGGTT
GCAGTCAACATCCTCAATGCTGCAGTGGATCTTGCAATAAGACTGCAGGCGTATGTC
5 TGTAAGCTGGTCTGCCGTCTGATATTCCCTTTCTGTGCTTTATCCTCTTTTGCCTGA
GTCATCCATACCTGTGAATGGTTAAGAGCCACTCAATACCTACTCCTCTGGGGGCTT
CAGAGGAACTACATTAAATAAAGCCACATTGCAACGAAAAAAAAAAAAAAAAAAAAA
(SEQ ID NO:237)

Translation:

MKLTCVVIIAVLFLTACQLDAAASYDKGKQKPPTLRPADKHFRLIKRCNARNSGCSQHP
QCCSGSCNKTAGVCL (SEQ ID NO:238)

Toxin Sequence:

Cys-Asn-Ala-Arg-Asn-Ser-Gly-Cys-Ser-Gln-His-Xaa3-Gln-Cys-Cys-Ser-Gly-Ser-Cys-Asn-
Lys-Thr-Ala-Gly-Val-Cys-Leu-^ (SEQ ID NO:239)

Name: Ra6.3

Species: rattus

Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGTGTGGTGATCATCGCCGTGCTGTTTCCTGACAGCCTGT
CAATTCGATACAGCTGCGAGCTACGACAAAGGTAAGCAGAAACCTCCTACTCTGAG
GCCAGCTGACAAACACTTCAGGTTGATCAAGCGTTGCAATGCTCGCAATAGTGGTT
GCAGTCAACATCCTCAATGCTGCAGTGGATCTTGCAATAAGACTTTGGGCGTATGTC
TGTAAGCTGGTCTGCCGTCTGATATTCCCTTTCTGTGCTTTATCCTCTTTTGCCTGA
GTCATCCATACCTGTGAATGGTTAAGAGCCACTCAATACCTACTCCTCTGGGGGCTT
30 CAGAGGAACTACATTAAATAAAGCCACATTGAAAAAAAAAAAAAAAAAAAAA (SEQ ID
NO:240)

Translation:

MKLTCVVIIAVLFLTACQFDTAASYDKGKQKPPTLRPADKHFRLIKRCNARNSGCSQHP
QCCSGSCNKTLGVCL (SEQ ID NO:241)

Toxin Sequence:

Cys-Asn-Ala-Arg-Asn-Ser-Gly-Cys-Ser-Gln-His-Xaa3-Gln-Cys-Cys-Ser-Gly-Ser-Cys-Asn-
Lys-Thr-Leu-Gly-Val-Cys-Leu-^ (SEQ ID NO:242)

Name: Sm6.1

Species: stercusmuscarum

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT

CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTGCCCTGAGGTTCGAAGACCAAACCTCTCCATGTTCGACTCGCTGCAAGAGTAAAGGA
 GCAAAATGTTCAAGGCTTATGTATGACTGCTGCAGCGGTTCTTGCAGCGGCTACACA
 GGTAGATGTGGCTGATCCAGCGCCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTG
 5 CCTGGGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGGA
 GGCCTCAGAGGAGTTACAATGAAATAAAAGCCGCATTGC (SEQ ID NO:243)

Translation:

MKLTCVVIVAVLLLTAQLITADDSRGTQKHRALRSKTKLSMSTRCKSKGAKCSRLMY
 10 DCCSGSCSGYTGRCG (SEQ ID NO:244)

Toxin Sequence:

Cys-Lys-Ser-Lys-Gly-Ala-Lys-Cys-Ser-Arg-Leu-Met-Xaa5-Asp-Cys-Cys-Ser-Gly-Ser-Cys-Ser-
 Gly-Xaa5-Thr-Gly-Arg-Cys-# (SEQ ID NO:245)

Name: Sm6.2

Species: stercusmuscarum

Isolated: Yes

Toxin Sequence:

Thr-Thr-Ser-Cys-Met-Gln-Ala-Gly-Ser-Xaa5-Cys-Gly-Ser-Thr-Thr-Arg-Ile-Cys-Cys-Gly-Xaa5-
 Cys-Ala-Xaa5-Phe-Gly-Lys-Lys-Cys-Ile-Asp-Xaa5-Xaa3-Ser-Asn-^ (SEQ ID NO:246)

Name: Sm6.3

Species: stercusmuscarum

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGACCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGGAGCATC
 GTGCCCTGAGGTTCGAAGACCAAACCTCTCCATGTAACTTTGCGCTGCGCATCTTACG
 GAAAACCTTGTGGTATTGACAACGACTGCTGCAATGCATGCGATCCAGCCAGAAAT
 35 ATATGTACGTAGCTGATCCGGCGTCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCT
 GCCTGAGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCATCTACTCTCCTGG
 AGGCCTCAGAGGAGCTACAATGAAATAAAAGCCGCATTGC (SEQ ID NO:247)

Translation:

MKLTCVVIVAVLLLTTCQLITADDSRGTQEHRLALRSKTKLSMLTLRCASYGKPCGIDND
 40 CCNACDPARNICT (SEQ ID NO:248)

Toxin Sequence:

Cys-Ala-Ser-Xaa5-Gly-Lys-Xaa3-Cys-Gly-Ile-Asp-Asn-Asp-Cys-Cys-Asn-Ala-Cys-Asp-Xaa3-
 45 Ala-Arg-Asn-Ile-Cys-Thr-^ (SEQ ID NO:249)

Name: Sm6.4
Species: stercusmuscarum
Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGTGTGGTGATTGTCGCCGTGCTGCTCCTGACGGCCTGT
 CAACTCATCACAGCTGATGACTCCAGAGGTACGCAGGAGCATCGTGCCCTGAGGTC
 GAAGACCAAACCTCTCCATGTAACTTTGCGCTGCGTATCTTACGGAAAACCTTGTGG
 TATTGACAACGACTGCTGCAATGCATGCGATCCAGCCAGAAATATATGTACGTAGC
 TGATCCGGCGTCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGGGTCCTCC
 TTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGGAGGCCTCAGAGGA
 GTTACAATGAAATAAAAAGCCGCATTGCAAAAAAAAAAAAAAAAAAAAAA (SEQ ID
 NO:250)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQEHRLRSKTKLSMLTLRCVSYGKPCGIDND
 CCNACDPARNICT (SEQ ID NO:251)

Toxin Sequence:

Cys-Val-Ser-Xaa5-Gly-Lys-Xaa3-Cys-Gly-Ile-Asp-Asn-Asp-Cys-Cys-Asn-Ala-Cys-Asp-Xaa3-
 Ala-Arg-Asn-Ile-Cys-Thr-^ (SEQ ID NO:252)

Name: S6.1
Species: striatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTTCCCTGAGGTGACCAACAAAGTCTCAAGGCGACTGACTGCATTGAAGCCGGA
 AATTATTGCGGACCTACTGTTATGAAAATCTGCTGCGGCTTTTGCAGTCCATACAGC
 AAAATATGTATGAACTATCCCAAAAATTGATCTTCCCCC (SEQ ID NO:253)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQKHRSLRSTTKVSKATDCIEAGNYCGPTVM
 KICCGFCSPYSKICMNYPKN (SEQ ID NO:254)

Toxin Sequence:

Ala-Thr-Asp-Cys-Ile-Xaa1-Ala-Gly-Asn-Xaa5-Cys-Gly-Xaa3-Thr-Val-Met-Lys-Ile-Cys-Cys-
 Gly-Phe-Cys-Ser-Xaa3-Xaa5-Ser-Lys-Ile-Cys-Met-Asn-Xaa5-Xaa3-Lys-Asn-^ (SEQ ID
 NO:255)

Name: S6.2
Species: striatus
Cloned: Yes

DNA Sequence:

GTCGACTCGCTGCAAGCTTAAAGGACAATCATGTCGTAGGACTATGTATGACTGCTG
 CAGCGGTTCTTGCGGCAGGAGAGGTAAATGTGGCTGATCCAGCGCCTGATCTCCCC
 5 CCTTCTGTGCTCTATCCTTTTCTGCCTGGGTCTCCTTACCTGAGAGTGGTCATGAAC
 CACTCATCACCTACTCCTCTGGAGGCCTCAGAGGAGCTACAATGAAATAAAAGCCG
 CATTGC (SEQ ID NO:256)

Translation:

10 STRCKLKGQSCRRTMYDCCSGSGRRGKCG (SEQ ID NO:257)

Toxin Sequence:

Cys-Lys-Leu-Lys-Gly-Gln-Ser-Cys-Arg-Arg-Thr-Met-Xaa5-Asp-Cys-Cys-Ser-Gly-Ser-Cys-
 Gly-Arg-Arg-Gly-Lys-Cys-# (SEQ ID NO:258)

Name: S6.3

Species: striatus

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATC
 GTGCCCTGAGGTTCGGACACCAAACCTCTCCATGTGCGACTCGCTGCAAGGCTGCAGGA
 25 AAATCATGCAGTAGGATTGCGTATAACTGCTGCACCGGTTCTTGCAGATCAGGTAA
 ATGCGGCTGATCCAGCGCCTGATCTTCCCCCTTCTGTGCTCTATCCTTTCTGCCTGAG
 TCCTCTTACCTGAGAGTGGTCATGAACC (SEQ ID NO:259)

Translation:

30 MKLTCVVIVAVLLLTACQLITADDSRGTQKHRALRSDTKLSMSTRCKAAGKSCSRIAYN
 CCTGSCRSKCG (SEQ ID NO:260)

Toxin Sequence:

35 Cys-Lys-Ala-Ala-Gly-Lys-Ser-Cys-Ser-Arg-Ile-Ala-Xaa5-Asn-Cys-Cys-Thr-Gly-Ser-Cys-Arg-
 Ser-Gly-Lys-Cys-# (SEQ ID NO:261)

Name: S6.6

Species: striatus

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAACTCATCACAGCTGATGACTCCAGAGGTACGCAGGAGCATC
 45 GTGCCCTGAGGTTCGGACACCAAACCTCTCCATGTAACTTTGCGCTGCGAATCTTACG
 GAAAACCTTGTGGTATTTACAACGACTGCTGCAATGCATGCGATCCAGCCAAAAAG
 ACATGTACGTAGCTGATCCGGCGTCTGATCT (SEQ ID NO:262)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQEHRAIRSDTKLSMLTLRCESYGKPCGIYND
CCNACDPAKKTCT (SEQ ID NO:263)

Toxin Sequence:

Cys-Xaa1-Ser-Xaa5-Gly-Lys-Xaa3-Cys-Gly-Ile-Xaa5-Asn-Asp-Cys-Cys-Asn-Ala-Cys-Asp-
Xaa3-Ala-Lys-Lys-Thr-Cys-Thr-^ (SEQ ID NO:264)

Name: w-SVIA
Species: striatus
Cloned: Yes

DNA Sequence:

ACTAGGTCCTCCGGCAGCCCCTGTGGTGTTACTAGTATATGCTGTGGTAGATGCTAT
AGGGGTAAATGTACGTAGCTCATCGGGCGTCTGATCTTCCCCCTTCTGTGCTCCATC
CTTTTCTGCCTGAGTCCTCCTTACCTGAGAGTGGTCGTGAACCACTCATCGCCTACTC
CTCTGGAGGCTTCAGAGGGGCTACACTAAAATAAAAGCTATATTGCAATGAAAAAA
A (SEQ ID NO:265)

Translation:

CRSSGSPCGVTSICCGRCYRGKCT (SEQ ID NO:266)

Toxin Sequence:

Cys-Arg-Ser-Ser-Gly-Ser-Xaa3-Cys-Gly-Val-Thr-Ser-Ile-Cys-Cys-Gly-Arg-Cys-Xaa5-Arg-
Gly-Lys-Cys-Thr-# (SEQ ID NO:267)

Name: w-SVIB
Species: striatus
Isolated: Yes

Toxin Sequence:

Cys-Lys-Leu-Lys-Gly-Gln-Ser-Cys-Arg-Lys-Thr-Ser-Xaa5-Asp-Cys-Cys-Ser-Gly-Ser-Cys-Gly-
Arg-Ser-Gly-Lys-Cys-# (SEQ ID NO:268)

Name: Sx6.1
Species: striolatus
Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGTCTTGCTGCTC
CTGACGACCTGTCGTCTCATCACAGCTGATGACTCCAGAGGTACGCAGAAGCATCG
TTCCCTGAGGTCGACTACTAAAGTCTCCATGTCGACTCGCTGCAAGGGTAAAGGAG
CATCATGTCTTAGGACTGCGTATGACTGCTGCACCGGTTCTTGCAACAGAGGTAGAT

GTGGCTGATCCAGCGTCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCTTGAGT
CCTCCTTA (SEQ ID NO:269)

Translation:

5 MKLTCVVIVVLLLLTTCRLITADDSRGTQKHRSLRSTTKVSMSTRCKGKGASCLRTAYD
CCTGSCNRGRG (SEQ ID NO:270)

Toxin Sequence:

10 Cys-Lys-Gly-Lys-Gly-Ala-Ser-Cys-Leu-Arg-Thr-Ala-Xaa5-Asp-Cys-Cys-Thr-Gly-Ser-Cys-
Asn-Arg-Gly-Arg-Cys-# (SEQ ID NO:271)

Name: Sx6.2

Species: striolatus

15 **Cloned:** Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTTCTGCTG
ACGGCGTGTCAACTCATCACAGCTGAGGACTCCAGAGGTACACAGAAGCATCGTAC
20 CCTGAGGTCGACCGTCAGACGCTCCAAGTCCGAGTTGACTACGAGATGCAGGCCTT
CAGGATCCAACCTGTGGTAATATTAGTATCTGCTGTGGTAGATGCGTTAACAGAAGAT
GTACGTAGCTCATCGGGCGTCTGATCTTTCCCC (SEQ ID NO:272)

Translation:

25 MKLTCVVIVAVLLTACQLITAEDSRGTQKHRTLRLSTVRRSKSELTTRCRPSGSNCGNISI
CCGRCVNRRT (SEQ ID NO:273)

Toxin Sequence:

30 Cys-Arg-Xaa3-Ser-Gly-Ser-Asn-Cys-Gly-Asn-Ile-Ser-Ile-Cys-Cys-Gly-Arg-Cys-Val-Asn-Arg-
Arg-Cys-Thr-^ (SEQ ID NO:274)

Name: Sx6.3

Species: striolatus

35 **Cloned:** Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTTCTGTTC
CTGACGGCGTGTCAACTCATCACAGCTGAGGACTCCAGAGGTACACAGAAGCATCG
40 TTCCCTGAGGTCGACTACCAAAGTCTCCAAGTCGACTAGCTGCATGAAAGCCGGGT
CTTATTGCGTCGCTACTACGAGAATCTGCTGCGGTTATTGCGCTTATTTTCGGCAAAA
TATGTATTGACTATCCCAAAAACCTGATCTTCCCCCTACTGTGCTCTATCCTTTT (SEQ
ID NO:275)

Translation:

45 MKLTCVVIVAVLFLTACQLITAEDSRGTQKHRSLRSTTKVSKSTSCMKAGSYCVATTRI
CCGYCAYFGKICIDYPKN (SEQ ID NO:276)

Toxin Sequence:

Ser-Thr-Ser-Cys-Met-Lys-Ala-Gly-Ser-Xaa5-Cys-Val-Ala-Thr-Thr-Arg-Ile-Cys-Cys-Gly-Xaa5-Cys-Ala-Xaa5-Phe-Gly-Lys-Ile-Cys-Ile-Asp-Xaa5-Xaa3-Lys-Asn-^ (SEQ ID NO:277)

Name: Tx6.15

Species: textile

Cloned: Yes

DNA Sequence:

GTTGACTCGGTACTGCACGCCTCATGGAGGACATTGTGGTTATCATAATGACTGCTG
CAGTCATCAATGCAATATAAACAGAAATAAATGTGAGTAGCTGATCTGGCATCTGA
TCTGTGCTCGTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGG
AGGC (SEQ ID NO:278)

Translation:

LTRYCTPHGGHCGYHNDCCSHQCINRNKCE (SEQ ID NO:279)

Toxin Sequence:

Xaa5-Cys-Thr-Xaa3-His-Gly-Gly-His-Cys-Gly-Xaa5-His-Asn-Asp-Cys-Cys-Ser-His-Gln-Cys-Asn-Ile-Asn-Arg-Asn-Lys-Cys-Xaa1-^ (SEQ ID NO:280)

Name: w-Tx

Species: textile

Isolated: Yes

Toxin Sequence:

Xaa5-Cys-Thr-Xaa3-Xaa5-Gly-Gly-His-Cys-Gly-Xaa5-His-Asn-Asp-Cys-Cys-Ser-His-Gln-Cys-Asn-Ile-Asn-Arg-Asn-Lys-Cys-Xaa1-^ (SEQ ID NO:281)

Name: C. tulipa w2

Species: tulipa

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
CCTGACGGCCTGTCAGCTCATCACAGCTCTGCACTCCAGAGGTACGCAGAAGCATC
GTGCCCTGGGGCGGACCACCAAACTCACCTTGTCGACTCGCTGCAAATCACCCGGA
TCTCCATGTTACCCGACTAGTTATAATTGCTGCTGGTCTTGCAGTCCATACAGAAAA
AAATGTAGGGGCTAATCCAGCGCCTGATTTTCCCCCTTCTGTGCTCTATTCTTTCTG
CCTGAGTCCTCCTTACCTGAAAGTGGTCATGAACCACTCATCACCTACTTCTCTGGA
GGCTTCGGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:282)

Translation:

MKLTCVVIVAVLLLLTACQLITALHSRGTQKHRALGRTTKLTLSTRCKSPGSPCSPTS SYNC
CWSCSPYRKRCRG (SEQ ID NO:283)

Toxin Sequence:

5 Cys-Lys-Ser-Xaa3-Gly-Ser-Xaa3-Cys-Ser-Xaa3-Thr-Ser-Xaa5-Asn-Cys-Cys-Xaa4-Ser-Cys-
Ser-Xaa3-Xaa5-Arg-Lys-Lys-Cys-Arg-# (SEQ ID NO:284)

Name: w-TVIA

10 **Species:** tulipa

Cloned: Yes

DNA Sequence:

15 ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
CCTGACGGCCTGTCAGCTCATCACAGCTCTGCACTCCAGAGGTACGCAGAAGCATC
GTGCCCTGGGGTCGACCACCAAACCTCACCTTGTGCTCGACTCGCTGCTTGTACCCGGAT
CTTCATGTTACCGACTAGTTATAATTGCTGCAGGTCTTGCAATCCATACAGCAGAA
AATGTAGGGGCTAATCCAGCGCCTGATCTTCCCCCTTCTGTGCTCTATTCCTTTCTGC
20 CTGAGTCCTCCTTACCTGAAAGTGGTCATGAACCACTCATCACCTACTTCTCTGGAG
GCTTCGGAGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:285)

Translation:

25 MKLTCVVIVAVLLLLTACQLITALHSRGTQKHRALGSTTKLTLSTRCLSPGSSCSPTS SYNC
CRSCNPYSRKRCRG (SEQ ID NO:286)

Toxin Sequence:

30 Cys-Leu-Ser-Xaa3-Gly-Ser-Ser-Cys-Ser-Xaa3-Thr-Ser-Xaa5-Asn-Cys-Cys-Arg-Ser-Cys-Asn-
Xaa3-Xaa5-Ser-Arg-Lys-Lys-Cys-Arg-# (SEQ ID NO:287)

Name: Vi6.1

Species: viola

Cloned: Yes

DNA Sequence:

35 ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
CCTGACGGCCTGTCAGCTCATTACAGCTGATGACTCCAGAGGTACGCAGTTGCATCG
TGCCCTGAGGAAGGCCACCAAACCTCCCCGTGTGCTCGACTCGCTGCATTACTTTAGGAAC
ACGATGTAAGGTTCCGAGTCAATGCTGCAGATCTTCTTGCAAGAACGGTTCGTTGTGC
40 TCCATCCCCTGAAGAATGGTAAATGTGGCTGATCCAGCGCCTGATCTTCCCCCTTCT
GACTGTCTCCGACCTTTTCTGCCTGAGTCCTCCTTACCTGAGAGGTGTCATGAACCA
CTCATCACCTACTCCCCTGGAAGCTTCAGAGGAGCTACATTGAAATAAAAGCCGCA
TTGC (SEQ ID NO:288)

Translation:

45 MKLTCVVIVAVLLLLTACQLITADDSRGTLHRLRKATKLPVSTRCITLGTRCKVPSQC
CRSSCKNGRCAPSPEEW (SEQ ID NO:289)

Toxin Sequence:

Cys-Ile-Thr-Leu-Gly-Thr-Arg-Cys-Lys-Val-Xaa3-Ser-Gln-Cys-Cys-Arg-Ser-Ser-Cys-Lys-Asn-Gly-Arg-Cys-Ala-Xaa3-Ser-Xaa3-Xaa1-Xaa1-Xaa4-^ (SEQ ID NO:290)

Name: Vi6.2

Species: viola

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
CCTGACGGCCTGTCAGCTCATTATAGCTGGGGACTCCAGAGGTACGCAGTTGCATCG
TGCCCTGAGGAAGGCCACCAAACTCTCCGTGTCGACTCGCTGCAAGAGTAGAGGAT
CATCATGTTCGTAGGACTTCGTATGACTGCTGCACGGGTTCTTGCAGAAATGGTAAAT
GTGGCTGATCCAGCGCCTGATCTTCCCCCTTCTGTGCTCCATCCTTTTCTGCCTGAGT
CCTCCTTACCTGAGAGTGGGCATGAACCACTCATCACCTACTCCCTGGAAGCTTCAG
AGGAGCTACATTGAAATAAAAGCCGCATTGC (SEQ ID NO:291)

Translation:

MKLTCVVIVAVLLLACQLIAGDSRGTLHRLRKATKLSVSTRCKSRGSSCRRTSYD
CCTGSCRNGKCG (SEQ ID NO:292)

Toxin Sequence:

Cys-Lys-Ser-Arg-Gly-Ser-Ser-Cys-Arg-Arg-Thr-Ser-Xaa5-Asp-Cys-Cys-Thr-Gly-Ser-Cys-Arg-Asn-Gly-Lys-Cys-# (SEQ ID NO:293)

Name: Vi6.3

Species: viola

Cloned: Yes

DNA Sequence:

ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGCGATCGTCGCCGTGCTGCT
CCTGACGGCCTGTCAGCTCATTACAGCTGAAGACTCCAGAGGTACGCATGAGCATC
TTGCCCTGAAGTCGACCTCCAAAGTCTCCAAGTCGACTAGCTGCATGGAAGCCAGA
TCTTATTGCGGACCTGCTACTACGAAAATCTGCTGCGATTTTGCAGTCCATTCAGC
GATAGATGTATGAACAATCCCAACAATTGATCTTCCCCCTTGTGTGCTCCATCTTTTC
TGCCTGAGTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTG
GAGGCTTCAGAGGAGTTACATTGAAATAAAAGCCGCATGC (SEQ ID NO:294)

Translation:

MKLTCVAIVAVLLLACQLITAEDSRGTHEHLALKSTSKVSKSTSCMEARSYCGPATTKI
CCDFCSPFSDRCMNNPNN (SEQ ID NO:295)

Toxin Sequence:

Ser-Thr-Ser-Cys-Met-Xaa1-Ala-Arg-Ser-Xaa5-Cys-Gly-Xaa3-Ala-Thr-Thr-Lys-Ile-Cys-Cys-

Asp-Phe-Cys-Ser-Xaa3-Phe-Ser-Asp-Arg-Cys-Met-Asn-Asn-Xaa3-Asn-Asn-^ (SEQ ID NO:296)

5 **Name:** Vi6.4
Species: viola
Cloned: Yes

DNA Sequence:

10 ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGCT
 CCTGACGGCCTGTCAGCTCATTACAGCTGAGGACTCCAGAGGTACGCAGTTGCATC
 GTGCCCTGAGGAAGACCACCAAACCTCTCCTTGTGACTCGCTGCAAGGGTCCAGGA
 GCCATATGTATAAGGATTGCGTATAACTGCTGCAAGTATTCTTGCGGAAATGGTAAA
 TGTGGCTGATCCAGCGCCTGATCTTCCCCCTTGTGTGCTCCATCCTTTTTCTGCCTGA
 15 GTCCTCCTTACCTGAGAGTGGTCATGAACCACTCATCACCTACTCCTCTGGAGGCTT
 CAGAGGAGCTACATTGAAATAAAAGCCGCATGC (SEQ ID NO:297)

Translation:

20 MKLTCVVIVAVLLLTAQLITAEDSRGTQLHRALRKTTKLSLSTRCKGPGAICIRIAYNC
 CKYSCGNGKCG (SEQ ID NO:298)

Toxin Sequence:

25 Cys-Lys-Gly-Xaa3-Gly-Ala-Ile-Cys-Ile-Arg-Ile-Ala-Xaa5-Asn-Cys-Cys-Lys-Xaa5-Ser-Cys-
 Gly-Asn-Gly-Lys-Cys-# (SEQ ID NO:299)

Name: Vi6.5

Species: viola

Cloned: Yes

DNA Sequence:

30 ACCAAAACCATCATCAAAATGAAACTGACGTGTGTGGTGATCGTCGCCGTGCTGTTC
 CTGACGGCCTGTCAATTCATCACAGCTGATGACTCCAGAAGTACGCAGAAGCATCG
 TGCCCTGAGGTCGACCACCAAACACTTTATGTTGACTTGGTACTGCACGCCTTATGG
 35 AGGACATTGTGGTTATTATAATGACTGCTGCAGTCATCAATGCAATATAAACAGAA
 ATAAATGTGAGTAGCTGATCCGGCATCTGATCTGTGCTCGCCCTAACCTGAGAGTGG
 TCATGAACCACTCATCATCTACTCCTCTGGAGGCTTCAGAGGAGCTACATGGAAATA
 AAAGCCGCATTGC (SEQ ID NO:300)

Translation:

40 MKLTCVVIVAVLFLTACQFITADDSRSTQKHRALRSTTKHFMLTWYCTPYGGHCGYYN
 DCCSHQCNINRNKCE (SEQ ID NO:301)

Toxin Sequence:

45 Xaa5-Cys-Thr-Xaa3-Xaa5-Gly-Gly-His-Cys-Gly-Xaa5-Xaa5-Asn-Asp-Cys-Cys-Ser-His-Gln-
 Cys-Asn-Ile-Asn-Arg-Asn-Lys-Cys-Xaa1-^ (SEQ ID NO:302)

Name: Pu6.4
Species: pulicarius
Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGCGTGCGTGGTGATTATCGCCGTGCTGTTCCCTGACGGCCTGT
 CAACTCATTACAGCTGAGACTTACTCCAGAGGTAAGCAGATGCACCGTGCTCTGAG
 GTCAACTGACAAAACTCCAAGTTGACCAGGGAATGCACACCTCCAGATGGAGCTT
 GTGGTTTACCTACACACTGCTGCGGGTTTTGCGATATGGCAAACAACAGATGTCTGT
 AAAGCGTCTGATATTCCCCTTCTGTGCTCTATCCTCTTTGGCCTGAGTCATCCATACC
 TGTGCTCGAG (SEQ ID NO:303)

Translation:

MKLTCVVIIAVLFLTACQLITAETYSRGKQMHRLRSTDKN SKLTRECTPPDGACGLPT
 HCCGFCDMANNRCL (SEQ ID NO:304)

Toxin Sequence:

Xaa1-Cys-Thr-Xaa3-Xaa3-Asp-Gly-Ala-Cys-Gly-Leu-Xaa3-Thr-His-Cys-Cys-Gly-Phe-Cys-
 Asp-Met-Ala-Asn-Asn-Arg-Cys-Leu-^ (SEQ ID NO:305)

Name: Pu6.6
Species: pulicarius
Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGCGTGCGTGGTGATTATCGCCGTGCTGTTCCCTGACGGCCTGT
 CAACTCATTACAGCTGAGACTTACTCCAGAGGTAAGCAGATGCACCGTGCTCTGAG
 GTCAACTGACAAAACTCCCAGTTGACCAGGGAATGCACACCTCCAGGTGGAGCTT
 GTGGTTTACCTACACACTGCTGCGGGTTTTGCGATATGGCAAACAACAGATGTCTGT
 AAAGCGTCTGATATTCCCCTTCTGTGCTCTATCCTCTTTGGCCTGAGTCATCCATACC
 TGTGCTCGAG (SEQ ID NO:306)

Translation:

MKLTCVVIIAVLFLTACQLITAETYSRGKQMHRLRSTDKN SQLTRECTPPGGACGLPT
 HCCGFCDMANNRCL (SEQ ID NO:307)

Toxin Sequence:

Xaa1-Cys-Thr-Xaa3-Xaa3-Gly-Gly-Ala-Cys-Gly-Leu-Xaa3-Thr-His-Cys-Cys-Gly-Phe-Cys-
 Asp-Met-Ala-Asn-Asn-Arg-Cys-Leu-^ (SEQ ID NO:308)

Name: Ra6.4
Species: rattus
Cloned: Yes

DNA Sequence:

GGATCCATGAAACTGACGTGTGTGGTGATCATCGCCGTGCTGTTTCCTGGCAGCCTGT
 CAACCTGTTACAACTGAGACTTTCTCCAGAGGTAAGGAGAAGCGTCGTGCTCTGAG
 5 GTCAACTGACGGCAACTCCCGGTTGACCAGGGCATGCACGCCTGAAGGTGGAGCCT
 GTAGTAGTGGGCGTCACTGCTGCGGCTTTTTCGATAACGTGTCCCACACGTGCTATG
 GTGAAACACCATCTCTCCACTGATGTTTCCCCTTCTGTGCTCTATCTTCTTTTGCCTG
 AGTCATCCATACCTGTGCTCGAG (SEQ ID NO:309)

Translation:

MKLTCVVIIAVLFLAACQPVTTFSTFRGKEKRRALRSTDGNSRLTRACTPEGGACSSGR
 HCCGFCDNVSHTCYGETPSLH (SEQ ID NO:310)

Toxin Sequence:

15 Ala-Cys-Thr-Xaa3-Xaa1-Gly-Gly-Ala-Cys-Ser-Ser-Gly-Arg-His-Cys-Cys-Gly-Phe-Cys-Asp-
 Asn-Val-Ser-His-Thr-Cys-Xaa5-Gly-Xaa1-Thr-Xaa3-Ser-Leu-His-^ (SEQ ID NO:311)

Name: Sm6.7

Species: *stercusmuscarum*

Cloned: Yes

DNA Sequence:

AGATCCATGAAACTGACGTGCGTGTTGATCGTCGCCGTGCTGCTCCTGACGGCCTGT
 25 CAACTCATCACAGCTGATGACTCCAGAGGTACGCAGGAGCATCGTGCCCTGAGGTC
 GGACACCAAACCTCCCCATATCGACTCGCTGCAAGGGTAAAGGAGCATCATGTCATA
 AGACTATGTATGACTGCTGCAGCGGTTTCCTGCACCAGAGGTAGATGTGGCTGATCC
 AGCGCCTGATCTTCCCCCTTCTGTGCTCTATCCTTTTCTGCCTGAGTCATCATACCTG
 TGCTCGAGCGTTACTAGTGGATCCGAGCTCGGTACCAAGCTTGGCGTAATCATAAA
 30 ANC (SEQ ID NO:312)

Translation:

MKLTCVVIVAVLLLTACQLITADDSRGTQEHRALRSDTKLPISTRCKGKGASCHKTMVD
 CCSGSCTRGRGCG (SEQ ID NO:313)

Toxin Sequence:

Cys-Lys-Gly-Lys-Gly-Ala-Ser-Cys-His-Lys-Thr-Met-Xaa5-Asp-Cys-Cys-Ser-Gly-Ser-Cys-Thr-
 Arg-Gly-Arg-Cys-# (SEQ ID NO:314)

Xaa1 = Glu or γ -Carboxy Glu

Xaa2 = Gln or pyroGlu

Xaa3 = Pro or Hydroxy Pro

Xaa4 = Trp or Bromo Trp

Xaa5 = Tyr, 125 I-Tyr, mono-iodo-Tyr or di-iodo-Tyr or O-sulpho-Tyr or O-Phospho-Tyr

^ = Free-carboxyl C-term or Amidated C-term, preferably Free-carboxyl

= Free-carboxyl C-term or Amidated C-term, preferably Amidated

TABLE2

Alignment of ω -Conopeptides (SEQ ID NO:)

5	Ar6.10 (F170)	---QCSANGGSC-TRHFH---CCSLYCNKDSSVCVATSYP^ (315)
	Ar6.2 (F074)	---TCNTPTHEYC-TLHRH---CCSGYCHKTIQACS^ (316)
	Ar6.3	---QCTPNGGSC-SRHFH---CCSLYCNKSTGVCIATSYP^ (317)
	Ar6.4 (F009)	---TCNTPTHEYC-TLHQH---CCSGYCHKTIQACS^ (318)
	Ar6.6 (F069)	---ECTPPGGACGLPT-H---CC-GFCDTANNRCL^ (319)
10	Ar6.7 (F073)	---TCNTPTHEYC-TLHQH---CCSGHCHKTIQACA^ (320)
	Ar6.8 (F169)	---QCSPIGGYC-TLHIH---CCSNHCIPIGRCVAT^ (321)
	Ar6.9 (F171)	---QCLPNGGYC-TLHIH---CCSDHCIPIDRCVAT^ (322)
	Ay6.1 (A653)	----CKGKGKPCSRIAYN---CCTGSCRS--GKC# (323)
	Ay6.2 (A654)	----CMEAGSYCG-STTR--ICC-GFCAYFGKKCIDYPSN^ (324)
15	Ay6.3 (J419)	----CKAKGKPCSRIAYN---CCTGSCRS--GKC# (325)
	Ay6.4	----CASYGKPCGIDN-D---CCNA-CDPGRNIC^ (326)
	Bu6.1	-STSCMEAGSYCGPATTK--ICC-DFCSPFSDRCMNNPNN^ (327)
	Bu6.2	----CITPGTRCKVPS-Q---CCRGPCCKNGR--CTPSPSEW^ (328)
	Bu6.3	----CATYGKPCGIQN-D---CC-NTCDPARRTCT^ (329)
20	Bu6.4	----CKGPGASCIRIAYN---CCKYSCRN--GKC# (330)
	Bu6.5	-STSCMAAGSYCGPATTN--ICC-DFCSPFSDRCMKKPNN^ (331)
	Bu6.6	----CKSKGSSCHRTSYD---CCTGSCRN--GRC# (332)
	C6.1	----CKSTGASCRRTSYD---CCTGSCRS--GRC# (333)
	C6.4	----CQGRGASCRKTMYN---CCSGSCN--RGSC# (334)
25	C6.5	----CLPAGESCLFSRIR---CC-GTCSSVLKSCVS^ (335)
	C6.6	----CQGRGGPCTKAVFN---CCSGSCN--RGRC# (336)
	C6.7	----CATYGKPCGIQN-D---CC-NTCDPARKTCT^ (337)
	C6.8	----CRGRGGPCTKAMFN---CCSGSCN--RGRC# (338)
	Ca6.4 (F168)	---QCSANGGSC-TRHFH---CCSLYCNKDSSVCVATSYP^ (339)
30	Cn6.1	----CASYGKPCGIDN-D---CC-NTCDPARKTCT^ (340)
	Cn6.2 (I583)	----CKGTGKPCSRIAYN---CCTGSCRS--GKC# (341)
	Cn6.3	-ATDCIEAGNYCGPTVMK--ICC-GFCSPYSKICMNYPQN^ (342)
	Cn6.4	----CKGKGASCTRLMYD---CCHGSCSSSKGRC# (343)
	Cn6.5 (I590)	----CKGKGASCHRTSYD---CCTGSCN--RGKC# (344)
35	Cn6.6 (I584)	----CASYGKPCGIYN-D---CC-NTCDPARKTCT^ (345)
	Cn6.7 (J409)	----CKGTGKPCSRIAYN---CCTGSCRS--GKC# (346)
	Cn6.8 (J407)	-STSCMKAGSYCR-STTR--TCC-GYCAIFGKFCIDFPSN^ (347)
	Cr6.1	----CKGKGASCRKTMYN---CCSGSCSN--GRC# (348)
	Cr6.2	-STSCMEAGSYCR-STTR--TCC-GYCSYFSKKCIDFPSN^ (349)
40	Cr6.3	----CKSKGAKCSRLMYD---CCSGSCSRYSGRC# (350)
	Cr6.4	-STGCMKAGSYCR-STTR--TCC-GYCAIFGKKCIDYPSN^ (351)
	Da6.8	---SCTPPGGPCGYYN-D---CCSHQCNISRNKCE^ (352)
	Di6.1	----CEDOGEOCGSDH-S---CCGGSCN--HNVCA^ (353)
	E6.2	---PCKPKGRKCFPHQKD---CCNKTCT--RSKCP^ (354)
45	E6.3	---ACWSSGTPCGTDS-L---CCGG-CNVSKSKCN^ (355)
	G6.1 (J420)	----CKSPGSSCSPTSYN---CCR-SCNPLYAKRCY# (356)
	G6.2 (J423)	----CKSPGTPCSRGMRD---CCT-PCLLYSNKC-R--RY^ (357)
	J410	----CLSPGSRCHKTMRN---CCT-SCSSYKGKCRP--RK^ (358)
	J411	----CKPPGRKCLNRKNE---CCSKFCNEHLHMC# (359)

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	J413	----	CKPPRRKCLKIKDK	----	CC-NFCNTHLNMCM#	(360)
	J414	----	CAGPGTIC--PNRV	----	CC-GYCSKRTHLCHS	RT# (361)
	La6.1	---	KCWPSGSYCRANS-K	---	CCSG-CDNRNRNKCY^	(362)
	La6.2	----	CLPPGSYCK-ATTE	----	VCCS-SCLQFAQIC	----S# (363)
5	L6.1	----	CKSPGSPCSVTSYN	----	CCT-FCSSYTKKCRA	SL^ (364)
	L6.2	----	CAGPGAIC--PNRV	----	CC-GYCSKRTHLCHS	RT# (365)
	L6.3	---	ACWSSGTPCGTDS-L	---	CCGG-CNVSKSKCN^	(366)
	L6.4	---	KCWSPGTYCRAHS-K	---	CCRG-CDQNRNKCY^	(367)
	La6.3	----	CKSPGSSCSVSMRN	----	CCT-SCNSRTKKCTR	--R# (368)
10	La6.4	---	TCWPSGTACGIDS-N	---	CCSG-CNVSRSKCN^	(369)
	La6.5	---	KCWPSGSYCRANS-K	---	CCSG-CDNRNRSKCN^	(370)
	Lp6.1 (JG4)		SLFECAPSGGRCGFLK-S	---	CCEGYCDGESTSCVSGPYSI^	(371)
	Lp6.2 (JG5)		WPLDCTAPSQPCGYFP-R	---	CCG-HCDV-RRVCTS#	(372)
	Lp6.3 (JG7)		----CMSPGGICGDFG-D	----	CCE-ICNV-YGICVSDLPGI^	(373)
15	Lp6.4 (JG15)		---YCAPPGGACGFFD-H	---	CC-GYCETFYNTC	-R^ (374)
	M6.1	----	CKGTGKPCSR IAYN	----	CCTGSCRS--GKC#	(375)
	M6.2	----	CASYGKPCGIYN-D	----	CC-NTCDPARKTCT^	(376)
	Mi6.1 (F157)	----	CNDRGGGC-SQHPH	----	CCGGTCNKLIGVCL^	(377)
	Mn6.1	----	CKSTGKSCSR IAYN	----	CCTGSCRS--GKC#	(378)
20	Mn6.2	----	CKGKGSSCSRTMYN	----	CCTGSCN--RGKC#	(379)
	O6.1		-SPPCMKGGSSCR-GTTG	----	VCC-GFCSDFGYKCRDYPQN^	(380)
	O6.2	----	CLPDGTSCLF SRIR	----	CC-GTCSSILKSCVS^	(381)
	P6.1	---	OCKTOGRKCF OHQKD	---	CCGRACI--ITICP^	(382)
	P6.2	---	SCKLOGAYCNAXDYD	---	CCLR-CKV-GGTC#	(383)
25	P6.3	---	PCKKTGRKCFPHQKD	---	CCGRACI--ITICP^	(384)
	Pu6.2 (JG28)	---	QCSPNGGSC-SRHFH	---	CCSLYCNKNTGVCIAT^	(385)
	Pu6.4 (AA678)	---	ECTPPDGACGLPT-H	---	CC-GFCDMANNRCL^	(386)
	Pu6.6 (AA681)	---	ECTPPGGACGLPT-H	---	CC-GFCDMANNRCL^	(387)
	R6.1	---	HGCKPLKRRCFNDKE	---	CCSKFCNSVRKQC#	(388)
30	R6.2	---	RGCKPLKRRCFNDKE	---	CCSKFCNSVRNQC#	(389)
	Ra6.1 (F206)	----	CNARNDCG-SQHSQ	----	CCSGSCNKTAGVCL^	(390)
	Ra6.2 (F205)	----	CNARNSGC-SQHPQ	----	CCSGSCNKTAGVCL^	(392)
	Ra6.3 (F207)	----	CNARNSGC-SQHPQ	----	CCSGSCNKTLGVCL^	(393)
	Ra6.4 (AA688)	---	ACTPEGGACSSGR-H	---	CC-GFCDNVSHTCYGETPSLH^	(394)
35	S6.1	----	ATDCIEAGNYCGPTVMK	----	ICC-GFCSPYSKICMNYPKN^	(395)
	S6.2	----	CKLKQQSCRRITMYD	----	CCSGSCGR-RGKC#	(396)
	S6.3	----	CKAAGKSCSR IAYN	----	CCTGSCRS--GKC#	(397)
	S6.6	----	CESYGKPCGIYN-D	----	CC-NACDPAKKTCT^	(398)
	Sm6.1 (J428)	----	CKSKGAKCSRLMYD	----	CCSGSCSGYTGRG#	(399)
40	Sm6.2	----	TTSCMQAGSYCG-STTR	----	ICC-GYCAYFGKKCIDYPSN^	(400)
	Sm6.3 (J429)	----	CASYGKPCGIDN-D	----	CC-NACDPARNICT^	(401)
	Sm6.4 (J431)	----	CVSYGKPCGIDN-D	----	CC-NACDPARNICT^	(402)
	Sm6.7 (AA689)	----	CKGKGASCHKTMYD	----	CCSGSCTRG--RC#	(403)
	Sx6.1	----	CKGKGASCLRTAYD	----	CCTGSCN--RGRC#	(404)
45	Sx6.2	----	CRPSGSNCGNIS-I	----	CCGR-CVN--RRCT^	(405)
	Sx6.3	----	STSCMKAGSYCV-ATTR	----	ICC-GYCAYFGKICIDYPKN^	(406)
	Tx6.15	---	YCTPHGGHC-GYHND	---	CCSHQCNINRNKCE^	(407)
	Vi6.1	----	CITLGTCKVPS-Q	----	CCRSSCKN--GRCAPSPEEW^	(408)
	Vi6.2	----	CKSRGSSCRRTSYD	----	CCTGSCRN--GKC#	(409)
50	Vi6.3	----	STSCMEARSYCGPATTK	----	ICC-DFCSPFSDRCMNNPNN^	(410)
	Vi6.4	----	CKGPGAICIRIAYN	----	CKKYSCGN--GKC#	(411)
	Vi6.5	---	YCTPYGGHCGYYN-D	---	CCSHQCNINRNKCE^	(412)

ω -Tx ----CTPYGGHCGYNH-D---CCSHQCNINRNKCE^ (413)
 C. tulipa ω 2 ----CKSWGSOCSOTSTN---CCW-SCSPYRKKC-R# (414)

EXAMPLE 3

In vivo Activity of ω -Conopeptide Frings Audiogenic Seizure Susceptible Mice

[0079] *In vivo* anticonvulsant activity of ω -conopeptides is analyzed in Frings audiogenic seizure susceptible mice as described by White et al. (1992). The ω -conopeptides are found to have anticonvulsant activity in this assay.

EXAMPLE 4

In vivo Activity of ω -Conopeptides in CF No. 1 Mice

[0080] *In vivo* anticonvulsant activity of ω -conopeptides is analyzed in CF No. 1 mice as described by White et al. (1995), using the maximal electroshock, subcutaneous pentylenetetrazole (Metrazol) seizure threshold and threshold tonic extension test. ω -Conopeptides are found to have anticonvulsant activity.

EXAMPLE 5

In Vivo Activity of ω -Conopeptides in Pentylenetetrazole-Induced Threshold Seizure Model

[0081] The *in vivo* activity of ω -conopeptides is analyzed using timed intravenous infusion of pentylenetetrazole (White et al., 1995). At time to peak effect, the convulsant solution (0.5% pentylenetetrazole in 0.9% saline containing 10 U.S.P. units/ml heparin sodium) is infused into the tail vein at a constant rate of 0.34 ml/min. The time in seconds from the start of the infusion to the appearance of the first twitch and the onset of clonus is recorded for each drug treated or control animal. The times to each endpoint are converted to mg/kg of pentylenetetrazole for each mouse, and mean and standard error of the mean are calculated. It is found that ω -conopeptides elevate the i.v. pentylenetetrazole seizure threshold.

EXAMPLE 6

In vivo Activity of ω -Conopeptides in Pain Models

[0082] The anti-pain activity of ω -conopeptides is shown in several animal models. These models include the nerve injury model (Chaplan, et al., 1997), the nociceptive response

to s.c. formalin injection in rats (Codene, 1993) and an NMDA-induced persistent pain model (Liu, et al., 1997). In each of these models it is seen that the ω -conopeptides and ω -conopeptides derivatives have analgesic properties.

[0083] More specifically, this study evaluates the effect of intrathecal administration of ω -conopeptides in mice models of nociceptive and neuropathic pain. For nociceptive pain, the effect of the ω -conopeptides is studied in two different tests of inflammatory pain. The first is the formalin test, ideal because it produces a relatively short-lived, but reliable pain behavior that is readily quantified. There are two phases of pain behavior, the second of which is presumed to result largely from formalin-evoked inflammation of the hind paw. An ω -conopeptide is administered 10 minutes prior to injection of formalin. The number of flinches and/or the duration of licking produced by the injection is monitored. Since the first phase is presumed to be due to direct activation of primary afferents, and thus less dependent on long term changes in the spinal cord, ω -conopeptides are presumed to have greatest effect on the magnitude of pain behavior in the second phase.

[0084] The mechanical and thermal thresholds in animals that received an injection of complete Freund's adjuvant into the hind paw are also studied. This produces a localized inflammation including swelling of the hind paw and a profound decrease in mechanical and thermal thresholds, that are detected within 24 hours after injection. The changes in thresholds in rats that receive ω -conopeptides are compared with those of rats that receive vehicle intrathecal injections.

[0085] An important issue is whether the drugs are effective when administered after the pain model has been established, or whether they are effective only if used as a pretreatment. Clearly, the clinical need is for drugs that are effective after the pain has developed. To address this issue, animals are studied in which ω -conopeptides are administered repeatedly, after the inflammation (CFA) or nerve injury has been established. In these experiments, an ω -conopeptide is injected daily by the intrathecal (i.t.) route. The mechanical and thermal thresholds (measured, respectively, with von Frey hairs in freely moving animals and with the Hargreave's test, also in freely moving animals) are repeated for a 2 to 4 week period after the injury is induced and the changes in pain measured monitored over time.

Effect of ω -Conotoxins in a Pain Model

[0086] Analgesic activity of ω -conotoxins is also tested in pain models as follows.

[0087] Persistent pain (formalin test). Intrathecal (it) drug injections are performed as described by Hylden and Wilcox (1980). An ω -conopeptide or vehicle is administered in a volume of 5 μ l. Fifteen minutes after the i.t. injection, the right hindpaw is injected with 20 μ l of 5% formalin. Animals are placed in clear plexiglass cylinders backed by mirrors to facilitate observation. Animals are closely observed for 2 minutes per 5 minute period, and the amount of time the animal spent licking the injected paw is recorded in this manner for a total of 45-50 minutes. Results are expressed as licking time in seconds per five minutes. At the end of the experiment, all animals are placed on an accelerating rotorod and the latency to first fall was recorded. ω -Conopeptides are found to be active in this model which is predictive of efficacy for treating neuropathic pain.

[0088] Acute pain (tail-flick). An ω -conopeptide or saline is administered intrathecally (i.t.) according to the method of Hylden and Wilcox (1980) in a constant volume of 5 μ l. Mice are gently wrapped in a towel with the tail exposed. At various time-points following the i.t. injection, the tail is dipped in a water bath maintained at 54 $^{\circ}$ C. and the time to a vigorous tail withdrawal is recorded. If there is no withdrawal by 8 seconds, the tail is removed to avoid tissue damage.

[0089] Neuropathic pain. The partial sciatic nerve ligation model is used to assess the efficacy of Mar1 in neuropathic pain. Nerve injury is produced according to the methods of Malmberg and Basbaum (1998). Animals are anesthetized with a ketamine/xylazine solution, the sciatic nerve is exposed and tightly ligated with 8-0 silk suture around 1/3 to 1/2 of the nerve. In sham-operated mice the nerve is exposed, but not ligated. Animals are allowed to recover for at least 1 week before testing is performed. On the testing day, mice are placed in plexiglass cylinders on a wire mesh frame and allowed to habituate for at least 60 minutes. Mechanical allodynia is assessed with calibrated von Frey filaments using the up-down method as described by Chaplan et al. (1994), and the 50% withdrawal threshold is calculated. Animals that did not respond to any of the filaments in the series are assigned a maximal value of 3.6 grams, which is the filament that typically lifted the hindlimb without bending, and corresponds to approximately 1/10 the animal's body weight.

[0090] The data obtained demonstrate that ω -conopeptides have potent analgesic properties in three commonly used models of pain: acute, persistent/inflammatory and neuropathic pain models.

EXAMPLE 8

Calcium-Channel Antagonist Activity: Inhibition of Ionic Currents

[0091] Ionic currents through calcium channels are examined in cells that are voltage-clamped by a single patch-clamp electrode. These whole-cell patch-clamp studies are performed mainly on N1E115 mouse neuroblastoma cells, although a variety of cell types, including human neuroblastoma cell line IMR-32, are also examined.

[0092] Most measurements are obtained using a bath saline that allowed examination of the calcium currents in the absence of other ionic currents. These solutions contained 80 mM NMDG (as a sodium replacement), 30 mM TEACl (to block potassium currents), 10 mM BaCl₂ (as a charge-carrier through the calcium channels), and 10 mM HEPES at pH 7.3. Some solutions also contained 2 mM quinidine (to block potassium currents) and 3 μ M tetrodotoxin (to block sodium currents). Normal bath saline is (mM): 140 NaCl, 10 glucose, 3 KCl, 2 CaCl₂, 1 MgCl₂, 10 mM HEPES pH 7.3. Intracellular solutions contained (mM): 150 CsCl, 0.5 CaCl₂, 5 EGTA, 5 MgCl₂, 2 K₂ATP at pH 7.3-7.4. Bath saline and all internal solutions are filtered before use.

[0093] Pipets are made from Corning 7052 glass (Garner Glass Company, Claremont, Calif. 91711), coated with Sylgard (Dow Corning, Midland, Mich. 48640) and fire-polished before use. Bubble numbers are typically 5 to 6, with pipet resistances typically 2-5 MOhms. Corning 8161, Kimble, and other glasses are also used without noticeable effect on the calcium currents observed.

[0094] Recordings are carried out at room temperature with an Axopatch 1-C amplifier (Axon Instruments, Foster City, Calif. 94404) and analyzed with pCLAMP software (Axon Instruments). Data are filtered at 1000 Hz for a typical sampling rate of 0.1 kHz; in all cases data are filtered at a frequency at most 1/5 of the sampling rate to avoid biasing. Data are collected on-line by the software. Analysis is performed on-screen with print-out via a Hewlett-Packard LaserJet Printer (Hewlett-Packard, Palo Alto, Calif. 94306).

[0095] The typical experiment is conducted as follows: after seal formation followed by series resistance compensation and capacitive transient cancellation, a voltage clamp protocol

is performed wherein the cell potential is stepped from the holding potential (typically -100 mV) to test potentials that ranged from -60 mV to +20 mV in 10 mV increments. The cell is held at the holding potential for 5 seconds between pulses. Protocols starting from other holding potentials usually covered the same range of test potentials. ω -Conopeptides are found to have calcium channel blocking activity in such cell lines.

[0096] It will be appreciated that the methods and compositions of the instant invention can be incorporated in the form of a variety of embodiments, only a few of which are disclosed herein. It will be apparent to the artisan that other embodiments exist and do not depart from the spirit of the invention. Thus, the described embodiments are illustrative and should not be construed as restrictive.

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